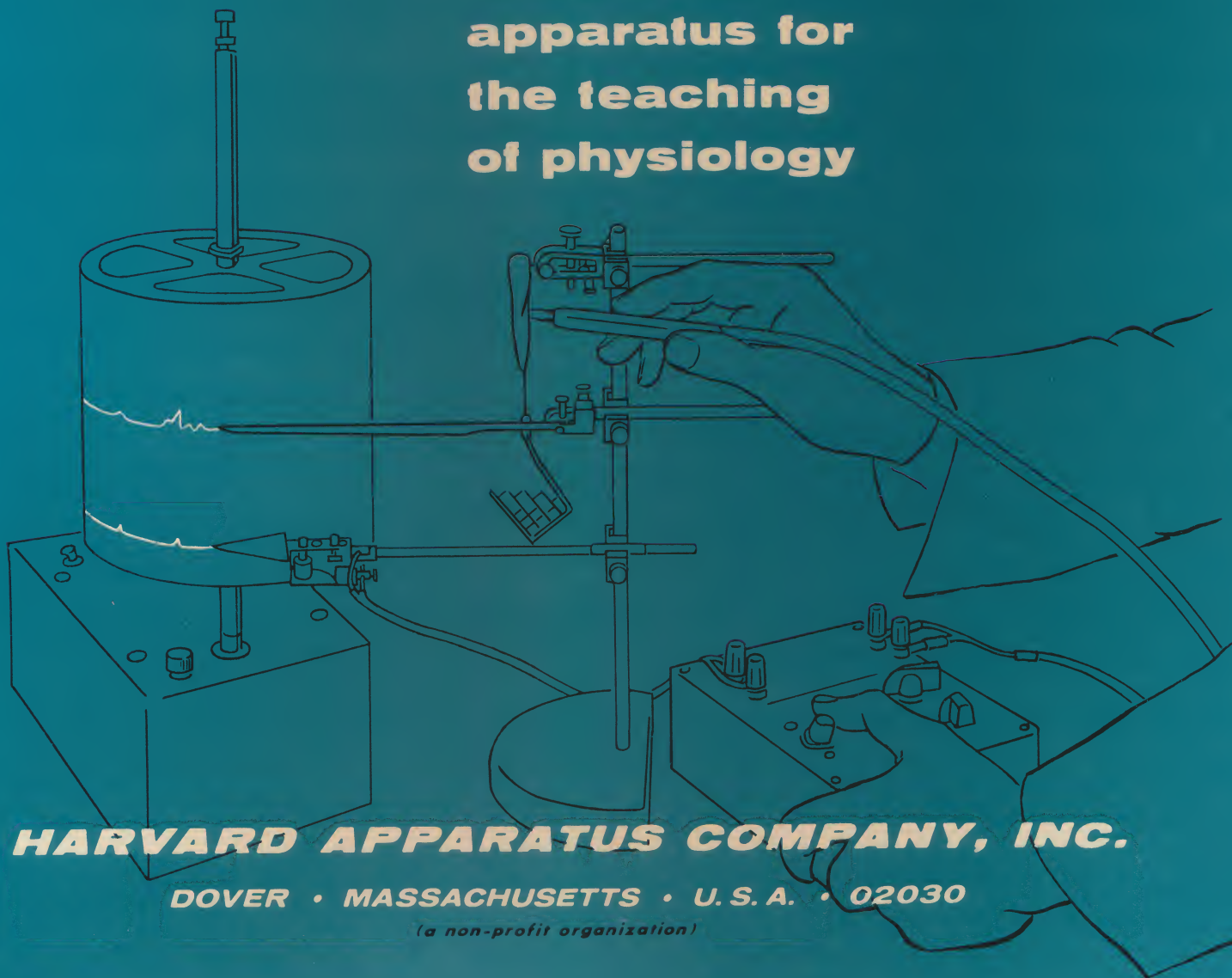




**catalog of
apparatus for
the teaching
of physiology**



HARVARD APPARATUS COMPANY, INC.

DOVER • MASSACHUSETTS • U. S. A. • 02030

(a non-profit organization)



*A non-profit organization for the ADVANCEMENT of RESEARCH and LABORATORY
TEACHING in PHYSIOLOGY and ALLIED SCIENCES*

PURPOSE AND POLICIES

The Harvard Apparatus Company, Inc., is a non-profit organization founded in 1904 by physiologists for the advancement of teaching and research in physiology and allied sciences by the design, development, manufacture and distribution of quality apparatus.

The Company is chartered under the General Laws of the Commonwealth of Massachusetts as an educational and scientific enterprise. These laws require that the net profits, if any, from the operation of the Company, shall be used for the promotion of teaching and research.

POLICY REGARDING DEALERS As a non-profit corporation, our products are available only to laboratories and persons or institutions engaged in teaching or research. Our products are not usually available through commercial dealers, agents or distributors except by the express wish of the ultimate recipient. In this case all charges or commissions incurred by an agent are collectable by him from the recipient.

TERMS Our terms are thirty (30) days net. We have no provisions for discounts, quantity discounts or commissions.

EXPORT CUSTOMERS Export shipments are handled by Mr. Donald J. Moore, P.O. Box 146, Wellesley, Massachusetts, U.S.A. — 02181. Requests for quotations and other information relative to overseas sales should be addressed directly to him.

If electrical equipment is ordered, please specify *voltage* and *frequency*.

ORDERING Orders will be expedited if the catalog number, as well as the description of the item, is included in the purchase order. Orders will not be honored except with official purchase order and/or authorized signature.

SHIPPING In general, all orders are shipped from stock. Unless instructed to the contrary, all available items are shipped and the remainder back ordered. Packing charges, except for overseas, are included in the price. Small packages are shipped Insured Parcel Post, larger shipments by Railway Express or any other method requested. All shipments are prepaid unless otherwise instructed and the cost is charged on the invoice. Evidence of shipment will be enclosed with invoice upon request. Packing lists are enclosed in each shipment and the customer is urged to check off items received.

REPAIR FACILITIES AND PARTS The Harvard Apparatus Company, Inc., stocks replacement and repair parts. When ordering, please describe parts as completely as possible and if practical enclose a sample or drawing. We offer a complete reconditioning service.

SPECIAL APPARATUS Our complete facilities are available for the design, development and manufacture of specialized apparatus to aid the teacher or researcher.

GUARANTEE All apparatus is unconditionally guaranteed to be free from original defects in workmanship and materials for a period of one full year from the date of purchase. This guarantee is limited to repair or replacement only.

Apparatus returned for any reason must be preceded by a letter or a letter must be attached to the outside of the box.

Apparatus will not be accepted for credit unless a written request has been received from the customer and permission given by Harvard Apparatus Company, Inc., for its return.

QUOTATIONS We will quote prices f.o.b. destination upon written request stating catalog number, description and quantity. All quotations are valid for 90 days unless otherwise specified.

This catalog is presented in order to give the teacher of physiology and biology a better understanding of the availability and use of a wide range of apparatus suited to the secondary school student laboratory.

The Company will also be happy to furnish upon request technical details on particular types of experiments.

GUIDE TO THE SELECTION AND USE OF APPARATUS for Laboratory Teaching of Physiology

Harvard Apparatus Co., Inc. is a non-profit organization founded by physiologists. The original purpose was to supply high-quality, low-cost apparatus to medical schools. In recent years, there has been an increased demand at the secondary school level for apparatus of more professional quality. In fact, many of the experiments originally performed only at the medical school and college level are now being successfully performed in secondary schools as standard student experiments.

Harvard Apparatus Co., Inc. offers an extensive range of equipment for student use including a variety of apparatus in kit form. All apparatus is of the highest quality, workmanship and materials. It is ruggedly designed to withstand continual classroom use, yet versatile enough to permit the student to perform a wide range of experiments with a minimum of apparatus.

RECORDING

In practically all phases of science, records of experiments are necessary. These records may be in representational form such as drawings and photographs or in abstract terms such as line graphs and digital writeouts. The decision to use one or another of these techniques generally depends on the nature of the experiment.

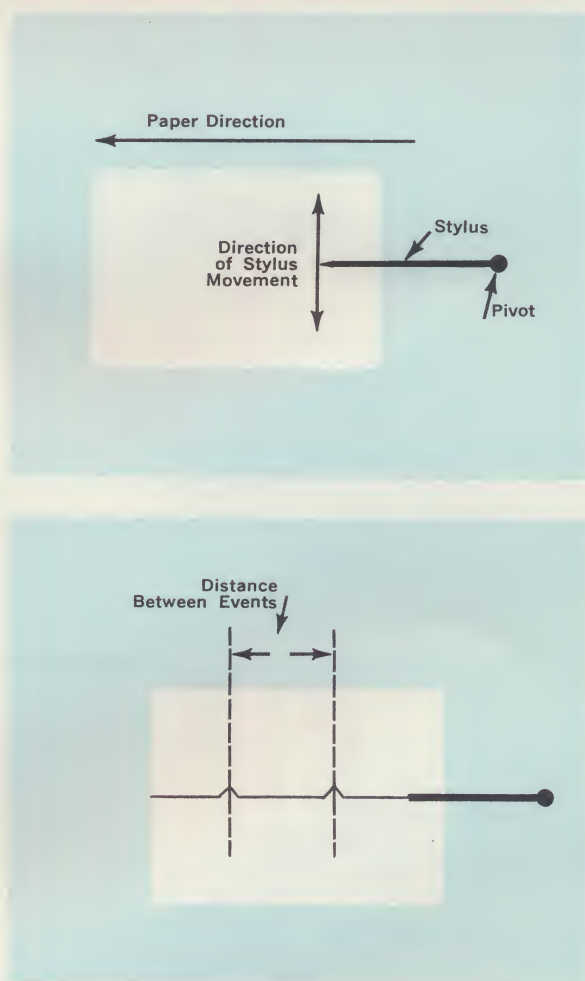
In high school physiology laboratories, the equipment on hand also plays an important role in the determination of technique.

The most practical and economical method of obtaining continuous and visible records in student laboratories is through the use of a kymograph or a chart mover, plus simple writing instruments and accessories.

Kymographic recording is based on the premise that most physiological phenomena can be translated into motion. This motion is transferred to a lever, or stylus, one end of which rests against a surface moving at a known rate of speed. The recording surface is a piece of paper wrapped around the kymograph drum which is continuously rotating away from the point of the stylus, although always maintaining contact. The stylus is so constructed that motion transferred to it by the experiment causes the stylus to move in directions perpendicular to the motion of the paper. Thus, the results of continuous experiments, together with time lapses, can be shown.

Since it is possible to know the speed at which the paper moves, and to measure with a ruler the distance between events recorded, one can determine the time lapses between events by the following equation:

$$\text{Time Lapse} = \frac{\text{Distance Between Events}}{\text{Paper Speed}}$$



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1

HARVARD APPARATUS COMPANY, INC.

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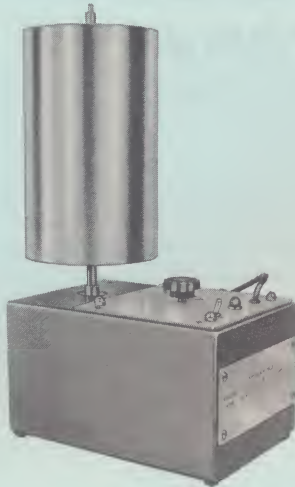


TYPES OF KYMOGRAPHS

Harvard Apparatus Co., Inc. manufactures three basic types of kymographs which differ from each other primarily in the type of driving mechanism used to rotate the drum. As each type has its own particular characteristics, the selection of a kymograph should be made in relation to the needs of the situation.

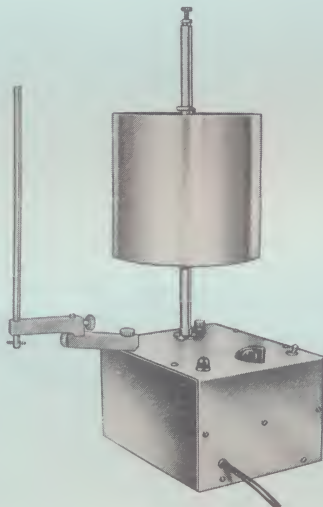
1. Synchronous Motor and Gear Types:

These kymographs are driven by a powerful synchronous motor used in conjunction with a 12-speed gearbox. The rate of drum rotation is exactly reproducible every time. The gearbox allows the choice of a 5,000 to 1 range in speeds. These kymographs are large, expensive, and thus are usually used in research laboratories.



2. Variable Speed Motor Types:

Kymographs of this type are equipped with a shaded pole motor, the speed of which can be varied over a 10:1 range by means of an electronic control. In addition, a 10:1 gearshift is provided, allowing a total range of 100 to 1 in drum speed. Because of the variable speed motor principle, it is not possible to know the exact drum speed at any time, thus requiring the use of a signal marker. (See page 7) **Model 440 Kymograph** is the least expensive machine available and is the one commonly used in secondary schools. It is manufactured in both standard and slow speed models. (Shown with Instrument Arm)



3. Spring Driven Kymographs:

These instruments have been manufactured continuously for more than seventy years and are to be found in every type of laboratory. Speed changing is accomplished by the use of various fans attached to the governor shaft. In addition, a 10:1 gearshift is provided, as well as a high-speed belt drive. By use of these various speed-governing methods, a total speed variation of 2200 to 1 is available. The extreme slow speed of all internal components contributes to many years of continuous use. **Model 401 Spring Kymograph** is somewhat more expensive than **Model 440** described above.



HARVARD PHYSIOLOGICAL APPARATUS

KYMOGRAPH ATTACHMENTS

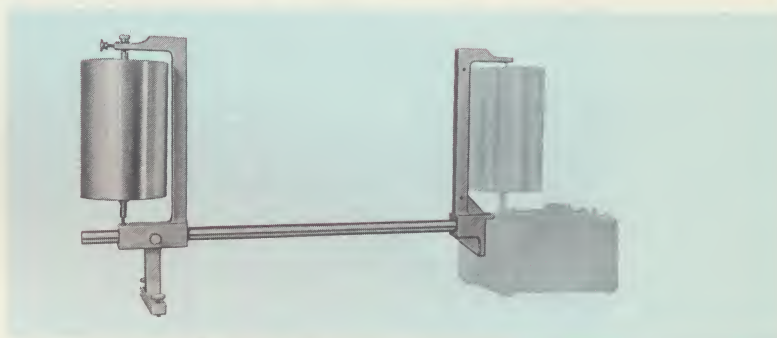
1. Swinging Instrument Arm:

This device attaches to the base of the kymograph or continuous recorder and allows recording instruments to be clamped to a rod and brought into proper relation to the drum. All kymographs have provisions for the attachment of this instrument arm.



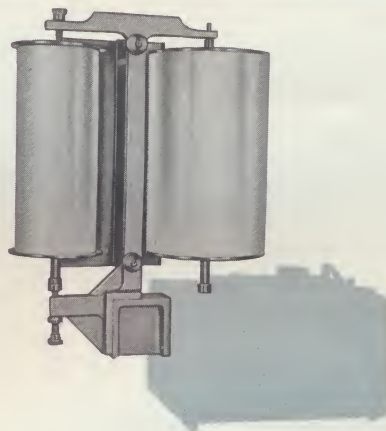
2. Long Paper Attachments:

These are auxiliary drums located some distance from the kymograph which allow the use of long continuous belts of paper. They are useful in long-term experiments. An attachment is available for each type of kymograph.



3. Continuous Recording Attachment:

This device allows an entire roll of paper to be used in conjunction with research kymographs. However, it is suitable only for ink writing.



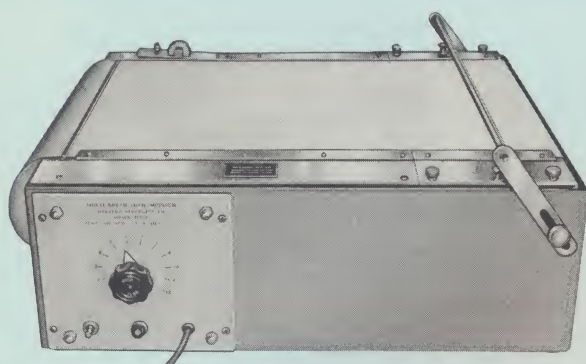
CONTINUOUS RECORDERS

In addition to its kymographs, Harvard Apparatus Co., Inc. manufactures two other devices for moving chart paper for recording purposes. These instruments are known as chart movers.

They consist of a rectangular chassis housing a large roll of recording paper, motor and/or gearbox. The paper is continuously drawn across the top of the recorder from right to left. Speeds can be changed while in operation.

In principle, this type of recording differs from kymograph recording only in that the paper is moved across a flat surface rather than being wrapped around a drum.

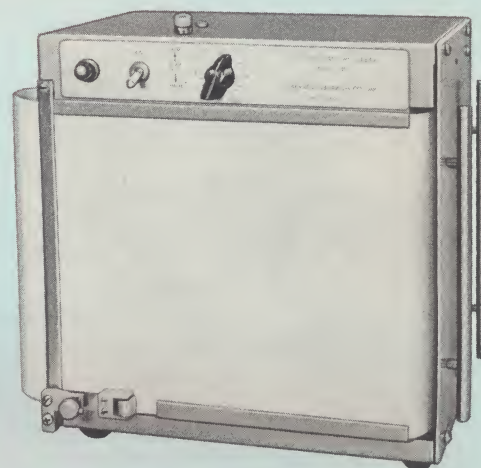
Continuous recording is of particular value in long-term experiments where continuous, uninterrupted records are required. The recorders are operational in either horizontal or vertical position.



2. **MODELS 450 and 451** employ a driving mechanism of the variable speed motor type covering a 100 to 1 speed range. Both models accept rolls of paper 8" wide by 125 yards long. **Model 450** moves paper in speeds from 12 mm./min. to 2200 mm./min. **Model 451** is identical, except that all speeds are reduced by a factor of ten. These recorders are designed for student use.

There are two types of **Chart Movers** (each suitable for ink writing only):

1. **MODEL 600-800** is equipped with a synchronous motor and a 12-speed gearbox. It accepts a roll of paper 10" wide by 125 yards long. Paper speeds are obtainable from 25 cm./sec. to 0.005 cm./sec.



WRITING TECHNIQUES

Harvard Apparatus Co., Inc. offers two basic techniques for producing permanent recordings.

1. Smoke Writing:

In this technique, highly glazed paper is wrapped around the kymograph drum and then rotated in a dense oily smoke. This is accomplished by means of a **Kerosene Smoker Lamp (cat. no. 420)**, or by a Bunsen burner with fish tail attachment.

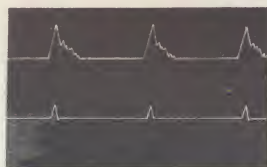
The writing styli remove the soot as the drum revolves, exposing sharp white lines. After the experiment is over, the record is preserved by either dipping the paper in a shellac mixture or by spraying its surface with lacquer. Smoke writing is an extremely economical as well as a sensitive technique. Smoked paper provides an excellent frictionless surface. However, suitable facilities, such as a hood, must be

available to cope with the smoking procedure. Also, the records are susceptible to smearing until suitably preserved. Since smoked paper cannot be rolled up, smoke writing precludes the use of any type of continuous recording system.

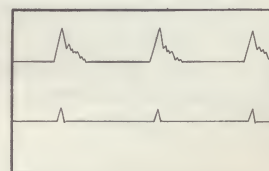
2. Ink Writing:

In this technique, the writing styli are actually hollow tubes that act as pens. The paper used is unglazed. The unique use of plastic ink bottles and tubing results in a trouble-free ink feed system. Ink writing is clean and neat, providing sharp black or red lines on white paper. Certain elementary rules, however, must be observed in the care and cleaning of pens after use. Although ink writing apparatus is more expensive, the convenience and saving in time more than offset the initial cost. Ink writing must be used on continuous recording systems.

Example of record produced by smoke writing.



Example of record produced by ink writing.



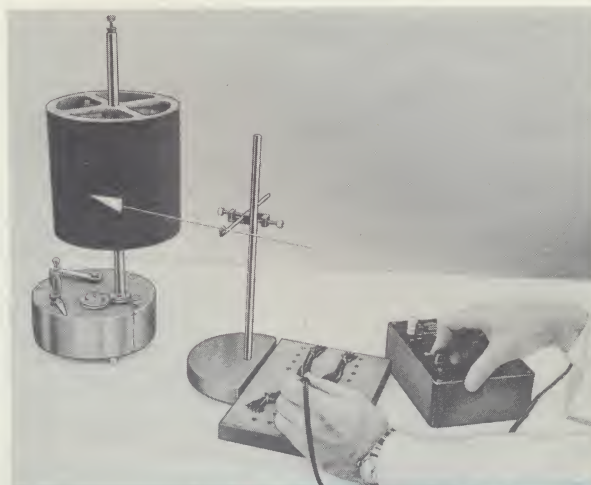
HARVARD PHYSIOLOGICAL APPARATUS

BASIC RECORDING INSTRUMENTS

In order to obtain records on the kymograph, various intermediate levers are used to translate the motion of the subject or preparation into a motion suitable for recording.

1. For Heart and Smooth Muscle Recording:

A simple light lever pivoted at the center is used to make records of heart and smooth muscle experiments. Levers available for smoke writing are **Models 220, 221, 222, 223**; and for ink writing, **Model 220-INK. Model 220** is adequate for all teaching laboratory use. The others differ in materials and overall length. A piece of parchment or celluloid is affixed to the end of the stylus in order to provide a flexible writing tip for smoked drum work.

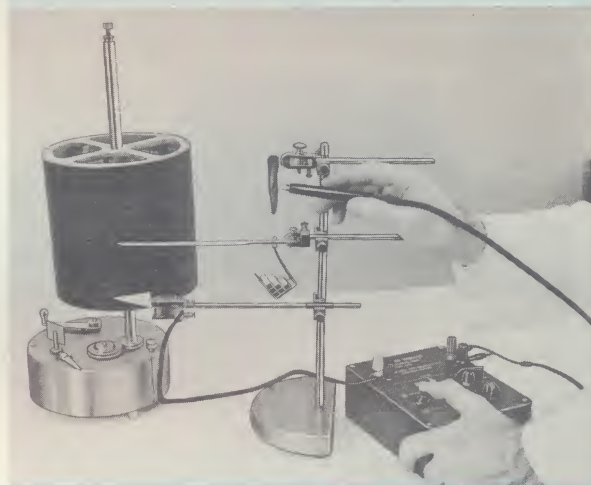


Typical setup for recording of an experiment involving electrical stimulation of frog heart.

2. For Skeletal Muscle Recording:

Models 225, 226, 227 Muscle Levers are available in either ink or smoke writing models. **Models 225 and 226** are most commonly used in frog work with the gastrocnemius preparation, while **Model 227** is used with preparations of the more powerful muscles.

A scale pan and weights are required for loading down the muscle. Either **Model 230-S** or **Model 230-L Scale Pans** can be used, the only difference being in capacity. Ten 10-gram weights are usually sufficient for one muscle preparation. A **Flat Jawed Femur Clamp, Model 211**, is usually required to hold the femur in the gastrocnemius preparation. **Double Clamps, Model 203**, are used to clamp the muscle lever and the femur clamp to a **Flat Base Stand, Model 501**. (Ordinary chemistry clamps and stands can be substituted satisfactorily.)



Typical setup for recording the effect of electrical stimulation of skeletal muscle preparation involving time base establishment.

3. For Recording of Respiration:

Model 605 Pneumograph is used in respiration studies. It is made of corrugated neoprene tubing with metal fittings at each end. One end is sealed air tight; the other end contains a nozzle which is connected to rubber or plastic tubing. The pneumograph is fastened around the chest of the subject. Breathing causes the corrugated tubing to stretch and contract alternately, thus producing a pressure change within the pneumograph. This pressure change is conducted through the tubing to a **Model 609** or **Model 610 Tambour**. The latter is equipped with a stylus which will record the breathing pattern on the kymograph.



Typical setup for recording of breathing patterns.

ELECTRICAL STIMULATION



In order to cause isolated skeletal muscles to contract, it is necessary to supply electrical stimulation either to the muscle itself or to the nerve attached to the muscle. Harvard Apparatus Co., Inc. offers three types of stimulators for this purpose.

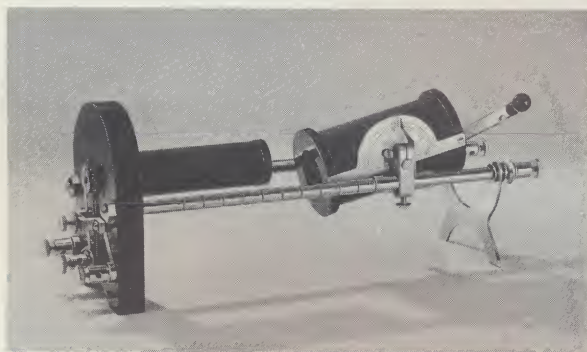
1. Model 340 Electronic Stimulator:

This instrument operates on 110V AC and provides square-wave pulses of fixed duration at frequencies and amplitudes which can be varied. A built-in auxiliary circuit can provide simultaneous current to a signal magnet at the time of stimulation.



2. Model 330 Induction Stimulator:

This device is similar to **Model 340** except that it has a self-contained battery and a fixed frequency of 40-50 CPS. Three voltage ranges are obtainable by means of a potentiometer control. This unit is widely used in secondary school laboratories.



3. Model 308 Inductorium:

This is the classic stimulator in use over the last half century. It consists of a vibrator, primary coil and moveable secondary coil. Voltage is controlled by moving the secondary. An external battery of 1½ volts must be used to operate the inductorium. A **Simple Key, Model 313**, is often used in series with the battery. The completely open construction of this unit has certain pedagogic values.

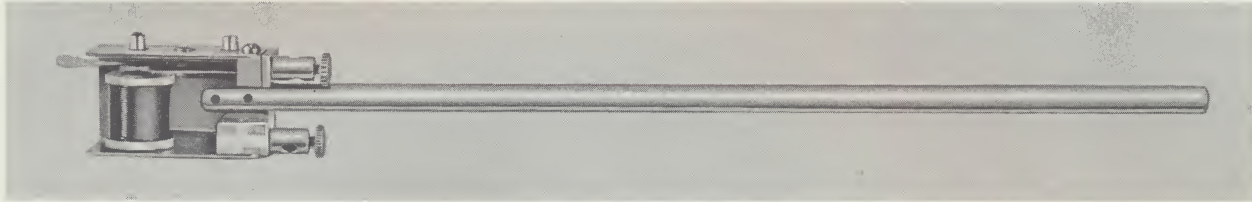


HARVARD PHYSIOLOGICAL APPARATUS

SIGNAL MARKERS

When it is desired to establish either a time base or to record the instant of an event, a signal magnet is used. This instrument consists of an electromagnet and a spring loaded armature extended out to form a stylus, which is in contact with the recording sur-

face. When current is applied, the stylus deflects, thus producing a permanent record. It can also be used as an independent time base marker, in which case a $1\frac{1}{2}$ volt dry cell is required to operate it. **Model 320 Signal Magnet** is adequate for all student work.



LABORATORY HARDWARE

Harvard Apparatus Co., Inc. offers a wide variety of laboratory clamps and stands; however, ordinary chemistry clamps and stands can be substituted satisfactorily in many cases.

SELECTION OF APPARATUS

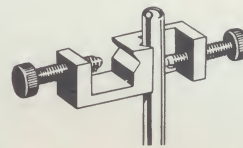
It is the suggestion of the Company that the teacher choose a minimum of equipment in order to achieve initial results. New equipment can always be ordered at a later date.

There are many excellent publications available to guide the teacher in setting up and performing experiments.* Such laboratory manuals show almost all of the standard experiments performed in basic physiology and list the various supplies needed for each experiment. They are also a valuable source for learning technique.

TEACHING KITS

To facilitate the choice of apparatus for the teaching of physiology in secondary schools, Harvard Apparatus Co., Inc. has prepared a number of kits containing various collections of apparatus. The kits vary in their content depending on the types of experiments that are to be performed. In all cases, the apparatus contained is identical to that usually furnished to medical schools. The total price of each kit is equal to the sum of the list prices of all of the apparatus included. Supplied with all kits, at no charge, is a copy of Zoethout's *Laboratory Experiments in Physiology*.

Although the following kits are listed with given catalog numbers and prices, teachers are encouraged to design their own kits by making substitutions or deletions. Again, the price of a kit will be the total of all of the apparatus selected. Kits listed are divided into ink or smoke writing types. There must be no mixture of ink and smoke writing equipment.



Large Double Clamp



Combination Offset and Swivel Clamp



#1000 Teaching Kit for nerve muscle and human physiology, equipped for smoke writing.

*Avis, Frederick R., *About Mice and Men*, J. Weston Walsh, Portland, Maine, 1962

Lawson, Chester A., ed., *Laboratory and Field Studies in Biology*, Holt, Rinehart and Winston, Inc., New York, New York, 1958

Zoethout, W. D., *Laboratory Experiments in Physiology*, The C. V. Mosby Company, St. Louis, Missouri

SIMPLE KYMOGRAPH TEACHING KIT FOR NERVE MUSCLE WORK, SMOKE WRITING
Contents of Kit #1005

Cat. No.	Quantity	Item	List Price
111	1	Cement, Colophonium Wax	.10
211	1	Flat Jawed Femur Clamp	5.00
220	1	Heart Lever, (Aluminum Wire)	3.00
226	1	Simplified Light Muscle Lever	4.50
230-S	1	Small Scale Pan	.75
231-10	10	Ten Gram Weights	Ten for 1.00
305	1	Silver Electrode (Hand Set)	3.05
320	1	27 mm Signal Magnet	6.50
330	1	Induction Stimulator	36.00
424-100	100	Sheets, Glazed Kymograph Paper, $7\frac{3}{16}$ " x $21\frac{1}{2}$ "	2.00
440	1	Electric Kymograph, Standard Model	85.00
—	1	Zoethout's "Laboratory Experiments in Physiology"	n.c.
			<hr/> \$146.90

All prices f.o.b. Dover, Mass.

Storage box, optional:

1010	1	Fitted Case for above, 24" x 12" x 12"	13.10
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SIMPLE KYMOGRAPH TEACHING KIT FOR NERVE MUSCLE WORK, INK WRITING
Contents of Kit #1005-INK

Cat. No.	Quantity	Item	List Price
211	1	Flat Jawed Femur Clamp	5.00
220-INK	1	Heart Lever, Ink Writing, complete	10.00
226-INK	1	Simplified Light Muscle Lever, Ink Writing, complete	11.50
230-S	1	Small Scale Pan	.75
231-10	10	Ten Gram Weights	Ten for 1.00
305	1	Silver Electrode (Hand Set)	3.05
320-INK	1	27 mm Signal Magnet, Ink Writing, complete	13.50
330	1	Induction Stimulator	36.00
425-100	100	Sheets, Ink Writing Paper, Uncoated, $7\frac{3}{16}$ " x $21\frac{1}{2}$ "	1.75
440	1	Electric Kymograph, Standard Model	85.00
803	2'	Ink Tubing @ .04/foot	.08
805	1	Ink Crystals, 2 oz., Black, (sufficient for 3 quarts)	.50
808	2'	Ink Cleaning Wire @ .01/foot	.02
—	1	Zoethout's "Laboratory Experiments in Physiology"	n.c.
			<hr/> \$168.15

All prices f.o.b. Dover, Mass.

Storage box, optional:

1010	1	Fitted case for above, 24" x 12" x 12"	13.10
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The above material represents specialized equipment not available in standard laboratories. A number of accessory items must be supplied by the user. These include chemistry stands and clamps and some sort of either cork or wooden board to hold down the preparation. The usual dissecting table will serve very well.



HARVARD PHYSIOLOGICAL APPARATUS

**STANDARD KYMOGRAPH TEACHING KIT FOR NERVE MUSCLE
AND HUMAN PHYSIOLOGY, SMOKE WRITING**

Contents of Standard Kit #1000

Cat. No.	Quantity	Item	List Price
111	1	Cement, Colophonium Wax	.10
203	2	Double Clamps, Stainless @ \$1.75	3.50
211	1	Flat Jawed Femur Clamp	5.00
213	1	Gaskell Clamp	7.50
220	1	Heart Lever, (Aluminum Wire)	3.00
225-ST	1	Flat Aluminum Stylus for Muscle Lever	.25
226	1	Simplified Light Muscle Lever	4.50
230-S	1	Small Scale Pan	.75
231-10	10	Ten Gram Weights	Ten for 1.00
251	1	Tuning Fork	2.50
252	1	Tuning Fork Starter	1.25
305	1	Silver Electrode (Hand Set)	3.05
320	1	27 mm Signal Magnet	6.50
330	1	Induction Stimulator	36.00
424-100	100	Sheets, Glazed Kymograph Paper, 7 $\frac{3}{16}$ " x 21 $\frac{1}{2}$ "	2.00
440	1	Electric Kymograph, Standard Model	85.00
501	1	Flat Base Stand	4.00
605	1	Pneumograph	6.50
609	1	Marey Tambour	8.50
620	1	Plethysmograph Tube	1.00
700	1	Frog Board (with clips)	3.00
1010	1	Fitted Case, 24" x 12" x 12"	13.10
—	1	Zoethout's "Laboratory Experiments in Physiology"	n.c.
			<u>\$198.00</u>

All prices f.o.b. Dover, Mass.

**STANDARD KYMOGRAPH TEACHING KIT FOR NERVE MUSCLE
AND HUMAN PHYSIOLOGY, INK WRITING**

Contents of the Standard Kit #1000-INK

Cat. No.	Quantity	Item	List Price
203	2	Double Clamps, Stainless @ \$1.75	3.50
211	1	Flat Jawed Femur Clamp	5.00
213	1	Gaskell Clamp	7.50
220-INK	1	Heart Lever, Ink Writing, complete	10.00
226-INK	1	Simplified Light Muscle Lever, Ink Writing, complete	11.50
230-S	1	Small Scale Pan	.75
231-10	10	Ten Gram Weights	Ten for 1.00
251-INK	1	Tuning Fork, Ink Writing, complete	9.50
252	1	Tuning Fork Starter	1.25
305	1	Silver Electrode (Hand Set)	3.05
320-INK	1	27 mm Signal Magnet, Ink Writing, complete	13.50
330	1	Induction Stimulator	36.00
425-100	100	Sheets, Ink Writing Paper, Uncoated, 7 $\frac{3}{16}$ " x 21 $\frac{1}{2}$ "	1.75
440	1	Electric Kymograph, Standard Model	85.00
501	1	Flat Base Stand	4.00
605	1	Pneumograph	6.50
609-INK	1	Marey Tambour, Ink Writing, complete	15.50
620	1	Plethysmograph Tube	1.00
700	1	Frog Board (with clips)	3.00
803	2'	Ink Tubing only @ .04/foot	.08
805	1	Ink Crystals, 2 oz., Black (sufficient for 3 quarts)	.50
808	2'	Ink Cleaning Wire @ .01/foot	.02
1010	1	Fitted Case, 24" x 12" x 12"	13.10
—	1	Zoethout's "Laboratory Experiments in Physiology"	n.c.
			<u>\$233.00</u>

All prices f.o.b. Dover, Mass.

**ADVANCED KYMOGRAPH TEACHING KIT FOR NERVE MUSCLE
AND HUMAN PHYSIOLOGY, SMOKE WRITING**

Contents of Kit #1055

Cat. No.	Quantity	Item	List Price
111	1	Cement, Colophonium Wax	.10
203	6	Double Clamps, Stainless @ \$1.75	10.50
211	1	Flat Jawed Femur Clamp	5.00
213	1	Gaskell Clamp	7.50
221	1	Heart Lever, Aluminum Tubing	4.50
221-A	1	Aluminum Tubing, 2 sections only	1.00
225	1	Muscle Lever, Light	6.00
225-ST	2	Flat Aluminum Stylus @ .25	.50
230-L	1	Large Scale Pan	1.25
230-S	1	Small Scale Pan	.75
231-5	10	Five Gram Weights	Ten for .90
231-10	10	Ten Gram Weights	Ten for 1.00
251	1	Tuning Fork	2.50
252	1	Tuning Fork Starter	1.25
260	1	Ergograph	24.00
304	1	Platinum Electrode (Hand Set)	3.75
313	1	Simple Key	3.00
317	1	Muscle Warmer	5.00
320	2	27 mm Signal Magnets @ \$6.50	13.00
340	1	Electronic Stimulator	80.00
420-5	1	Smoker Lamp, 5" wide wick, complete	28.50
424-75	2	Rolls, Glazed Paper, 7½" x 300' @ \$3.00	6.00
424-100	200	Sheets, Glazed Kymograph Paper, 7¾" x 21½" @ \$2.00/100 sheets	4.00
440-405-6	1	Long Paper Electric Kymograph, complete with 6" Drums	160.00
440-407	1	Swinging Instrument Arm for #440	10.00
501	1	Flat Base Stand	4.00
605	1	Pneumograph	6.50
609	1	Marey Tambour	8.50
610	1	Sphygmograph Tambour	7.50
620	1	Plethysmograph Tube	1.00
700	1	Frog Board (with clips)	3.00
1010	1	Fitted Case, 24" x 12" x 12" (for storage of all apparatus except the #440-405-6 Long Paper Kymograph, and the #440-407 Swinging Instrument Arm)	13.10
—	1	Zoethout's "Laboratory Experiments in Physiology"	n.c.
			<hr/> \$423.60

All prices f.o.b. Dover, Mass.



HARVARD PHYSIOLOGICAL APPARATUS

**ADVANCED CHART MOVER TEACHING KIT FOR NERVE MUSCLE
AND HUMAN PHYSIOLOGY, INK WRITING**

Contents of Kit #1065-INK

Cat. No.	Quantity	Item	List Price
203	6	Double Clamps, Stainless @ \$1.75	10.50
211	1	Flat Jawed Femur Clamp	5.00
213	1	Gaskell Clamp	7.50
220-INK	1	Heart Lever, Ink Writing, complete	10.00
225-INK	1	Muscle Lever, Light, Ink Writing, complete	13.00
230-L	1	Large Scale Pan	1.25
230-S	1	Small Scale Pan	.75
231-5	10	Five Gram Weights	Ten for .90
231-10	10	Ten Gram Weights	Ten for 1.00
251-INK	1	Tuning Fork, Ink Writing, complete	9.50
252	1	Tuning Fork Starter	1.25
260-INK	1	Ergograph, Ink Writing, complete	31.00
304	1	Platinum Electrode (Hand Set)	3.75
313	1	Simple Key	3.00
317	1	Muscle Warmer	5.00
320-INK	2	27 mm Signal Magnets, Ink Writing, complete @ \$13.50	27.00
340	1	Electronic Stimulator	80.00
425-8	1	Roll, Uncoated Paper, 8" x 375'	3.25
440-407	1	Swinging Instrument Arm	10.00
450	1	Chart Mover, 8" Paper, Standard Model	125.00
501	1	Flat Base Stand	4.00
605	1	Pneumograph	6.50
609-INK	1	Marey Tambour, Ink Writing, complete	15.50
610-INK	1	Sphygmograph Tambour, Ink Writing, complete	14.50
620	1	Plethysmograph Tube	1.00
700	1	Frog Board (with clips)	3.00
802	1	Ink Bottle only and tubing	.50
803	2'	Ink Tubing only @ .04/foot	.08
804-12	1	Ink Pen & Adapter for #225, etc.	5.00
805	1	Ink Crystals, 2 oz., Black, (sufficient for 3 quarts)	.50
808	7'	Ink Cleaning Wire @ .01/foot	.07
1010	1	Fitted Case, 24" x 12" x 12" (for storage of all apparatus except the #450 Chart Mover and #440-407 Swinging Instrument Arm)	13.10
—	1	Zoethout's "Laboratory Experiments in Physiology"	n.c.
			<hr/> \$412.40

All prices f.o.b. Dover, Mass.

COMPLETE MASTER RESEARCH AND DEMONSTRATION KIT, INK WRITING
Contents of Kit #1075-INK

Cat. No.	Quantity	Item	List Price
201	1	Adjusting Clamp	12.00
203	12	Double Clamps, Stainless @ \$1.75	21.00
208	2	Swivel-Offset Clamps @ \$6.00	12.00
211	1	Flat Jawed Femur Clamp	5.00
213	1	Gaskell Clamp	7.50
214	1	Isometric Tension Clamp	15.00
215	1	Threaded Femur Clamp	5.00
220-INK	1	Heart Lever, Ink Writing, complete	10.00
225-INK	1	Muscle Lever, Light, Ink Writing, complete	13.00
228-INK	1	Light Isometric Lever, Ink Writing, complete	11.00
229-INK	1	Heavy Isometric Lever, Ink Writing, complete	17.00
230-S	1	Small Scale Pan	.75
230-L	1	Large Scale Pan	1.25
231-5	10	Five Gram Weights	Ten for .90
231-10	10	Ten Gram Weights	Ten for 1.00
251-INK	1	Tuning Fork, Ink Writing, complete	9.50
252	1	Tuning Fork Starter	1.25
260-INK	1	Ergograph, Ink Writing, complete	31.00
301	1	Electrical Timer	85.00
304	1	Platinum Electrode (Hand Set)	3.75
310-T	1	Transistorized Interrupter	42.50
313	1	Simple Key	3.00
315	1	Moist Nerve Plate	8.00
317	1	Muscle Warmer	5.00
318	1	Nerve Conduction Chamber	13.50
320-INK	2	27 mm Signal Magnets, Ink Writing, complete @ \$13.50	27.00
331	1	Holder for Platinum or Silver Electrodes	5.00
340	1	Electronic Stimulator	80.00
341	1	Pulse Adapter for #340 only	22.00
425-8	1	Uncoated Paper, Roll, 8" x 375'	3.25
440-407	1	Swinging Instrument Arm	10.00
450	1	Chart Mover, 8" Paper, Standard Model	125.00
605	1	Pneumograph	6.50
609-INK	1	Marey Tambour, Ink Writing, complete	15.50
610-INK	1	Sphygmograph Tambour, Ink Writing, complete	14.50
620	1	Plethysmograph Tube	1.00
700	1	Frog Board (with clips)	3.00
803	2'	Ink Tubing only @ .04/foot	.08
804-12	1	Ink Pen & Adapter for #225, etc.	5.00
805	1	Ink Crystals, 2 oz., Black, (sufficient for 3 quarts)	.50
808	7'	Ink Cleaning wire @ .01/foot	.07
1010	1	Fitted Case, 24" x 12" x 12" (for storage of all apparatus except the #450 Chart Mover and #440-407 Swinging Instrument Arm)	13.10
—	1	Zoethout's "Laboratory Experiments in Physiology"	n.c.
			\$666.40

All prices f.o.b. Dover, Mass.



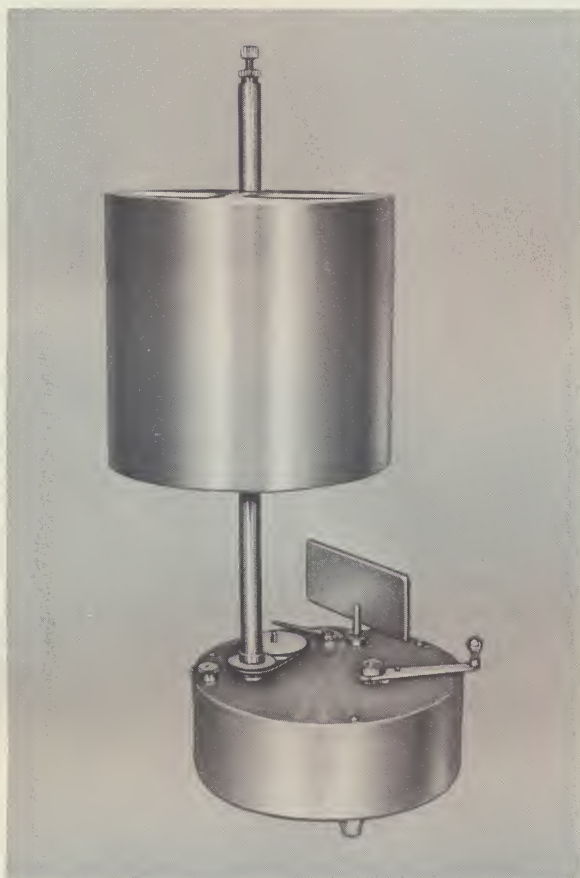
HARVARD APPARATUS CO., INC. • Dover, Mass., U.S.A. 02030

(a non-profit organization)

Tel.: 785-0700
Area Code: 617

APPARATUS FOR BASIC PHYSIOLOGY

I. KYMOGRAPHS, RECORDERS AND SUPPLIES



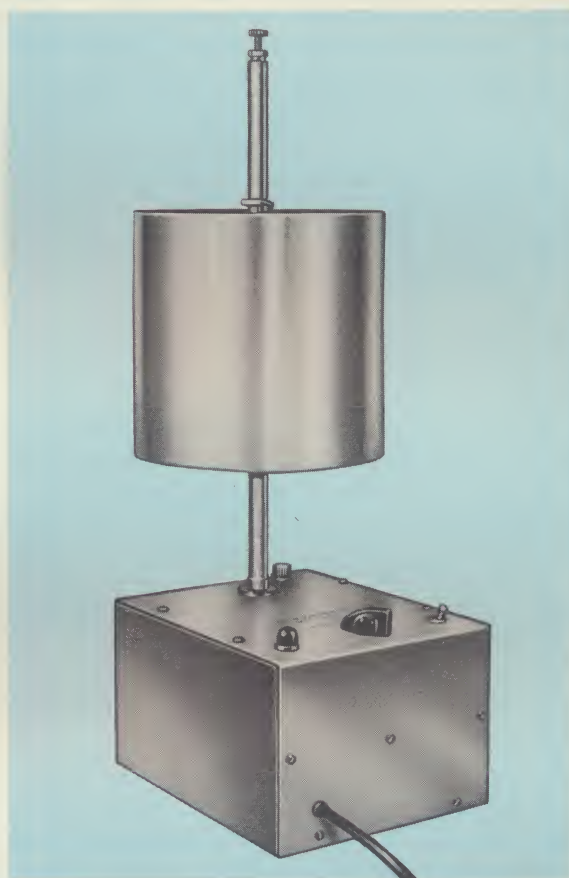
401-6 MEDIUM SPRING KYMOGRAPH A simple, rugged, spring-wound kymograph. Four fans vary the speed in addition to a 10:1 gear shift. A high-speed belt is provided for a drum speed of one revolution per second intended for muscle twitch experiments. The aluminum drum is 50 cm. in circumference and 6" high. Altogether 15 different speeds are available from 50 cm. per second to 50 cm. in 38 minutes.

401-10 Same as 401-6 except with 10" high drum.

402-6 SLOW AND FAST SPRING KYMOGRAPH Same as 401-6 except with stronger spring for faster, more powerful operation. A pendulum escapement mechanism provides extremely slow speeds as low as 50 cm. rotation in 16 hours.

402-10 Same as 402-6 except with 10" high drum.

R401 REPAIR KIT FOR 401 MEDIUM SPRING KYMOGRAPH Compartmented plastic case containing fans, brake levers and assorted parts most commonly required for replacement.



440-6 ELECTRIC KYMOGRAPH A simple inexpensive electric kymograph featuring a variable speed motor and gear shift permitting an infinite number of speeds from 426 cm./min. to 5 cm./min. The kymograph base measures 6" x 7½" and is 5" high. Furnished with standard aluminum drum 6" high by 50 cm. circumference. Complete with engraved panel, nine-foot cord, pilot light and switch.

440-10 Same as 440-6 except with 10" high drum.

440-407 SWINGING INSTRUMENT ARM An accessory arm fastening to the top of all electric kymographs. Identical to 600-407.

441-6 ELECTRIC KYMOGRAPH LOW SPEED Identical to 440-6 except that all speeds are reduced by a factor of 10. High speed 42 cm./min., low speed 0.5 cm./min.

441-10 Same as 441-6 except with 10" high drum.

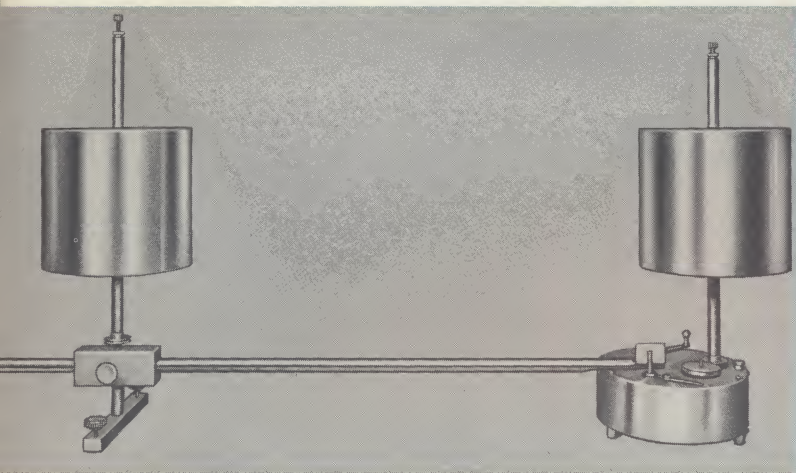
441-407 SWINGING INSTRUMENT ARM only for 441 electric kymographs.

A non-profit Organization
for the Advancement of
Research and Laboratory
Teaching in Physiology
and Allied Sciences.

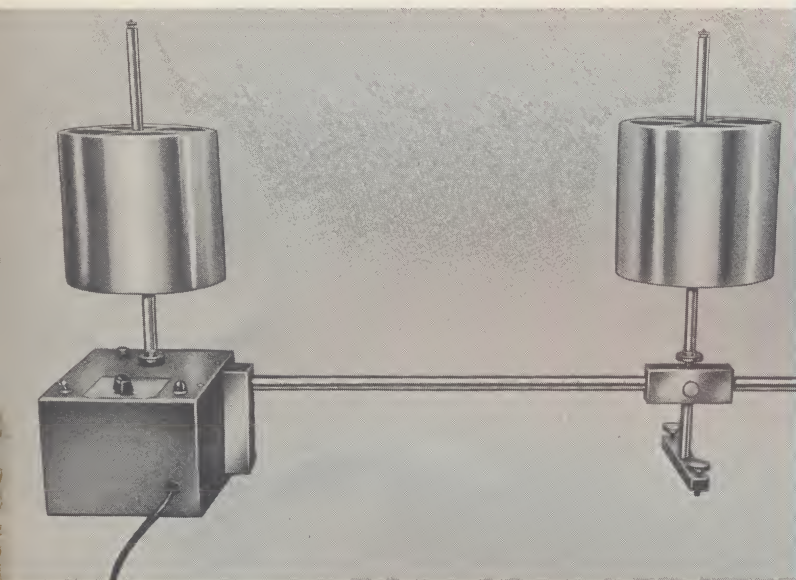


HARVARD APPARATUS CO., INC.

DOVER, MASSACHUSETTS 02030



403 KYMOGRAPH, LONG PAPER, SPRING A strong-spring kymograph attached to a nicked brass framework with a rear cylinder. A continuous belt of paper from 150 to 240 cm. may be stretched between the drums. Tension adjustments provided. The driving mechanism is readily removed and can be converted to a single-drum kymograph. Available with 6" high drums only.



440-405-6 LONG PAPER ELECTRIC KYMOGRAPH, COMPLETE An aluminum extension bar and auxiliary rear 6" drum assembly attached to the 440-6 Electric Kymograph. The maximum available distance between drum is 36".

441-405-6 LONG PAPER SLOW SPEED ELECTRIC KYMOGRAPH, COMPLETE Identical to 440-405-6 except for substitution of slow speed Electric Kymograph 441-6.



600-404-10 ELECTRIC KYMOGRAPH Ten inch high drum using 600 gear box.

Specifications:

- Twelve paper speeds (see chart below)
- Powerful synchronous instrument motor
- Speeds selected by knob, while in operation
- Heavy steel base
- Rubber feet, 9' cord, pilot light and switch
- Engraved speed table on base
- Precision turned aluminum drum
- Complete accessories available
- Height 20", base 7½" x 11"

600-040-6 ELECTRIC KYMOGRAPH Same as above but with 6" high drum.

**DRIVING MECHANISM
FOR 600-404 KYMOGRAPHS**

600-404 Kymographs are driven by a Multi-Speed Transmission. The transmission consists of a complete motorized gear reducer module with 12 gear shift positions covering a 500 to 1 overall range. A synchronous instrument motor assures constant, reproducible speeds. Heavy, precision-cut brass gears and steel pinions are used throughout. The gear selector knob allows the instantaneous selection of any speed and neutral while the kymograph is in operation.

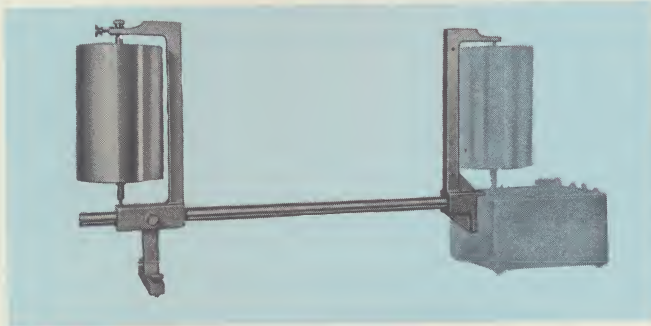
**PAPER SPEED for 600-404 KYMOGRAPHS
cm./sec.**

Knob Position	Paper Speed	Knob Position	Paper Speed
1	50	7	.5
2	20	8	.25
3	10	9	.1
4	5	10	.05
5	2.5	11	.025
6	1	12	.010



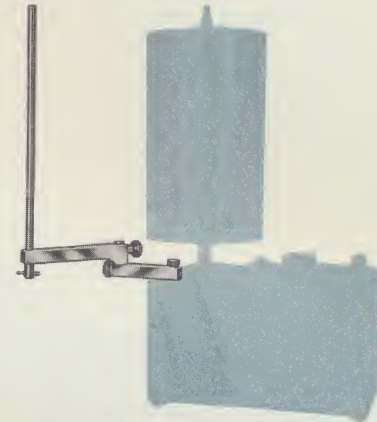
HARVARD PHYSIOLOGICAL APPARATUS

ACCESSORIES FOR 600-604 KYMOGRAPHS



600-405-10 LONG PAPER ATTACHMENT Cast aluminum frames and rigid bar support a 10" rear auxiliary drum. Tension and tilt adjustments provided. Will accommodate belts of paper up to 225 cm. in circumference.

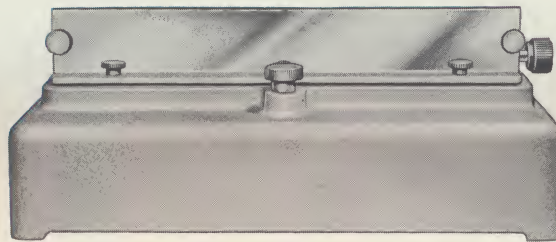
600-405-6 LONG PAPER ATTACHMENT Same as above except with 6" high drum.



600-407 SWINGING INSTRUMENT ARM

Anodized aluminum and stainless steel stand fastened to the top of the kymograph base. The jointed construction affords great flexibility.

KYMOGRAPH SUPPLIES and ACCESSORIES



420-5 SMOKER LAMP Kerosene burning lamp with even burning wick 5" long. Heavy steel base with aluminum frame. Capacity 1 quart.

420-9 SMOKER LAMP Same as above except with 9" long wick.

420-5 WICK Replacement wick only, for 5" smoker lamp.

420-9 WICK Replacement wick only, for 9" smoker lamp.

PAPER, GLAZED White glazed paper intended for smoked drum recording.

424-10 ROLLS 10" wide x 100 yards long.

423-75 ROLLS 7½" wide x 100 yards long.

424-100 SHEETS 7¾" x 21½", pkg. of 100 sheets.

424-115 ROLLS 11½" wide x 100 yards long.

PAPER, UNCOATED White recording paper intended for ink recording.

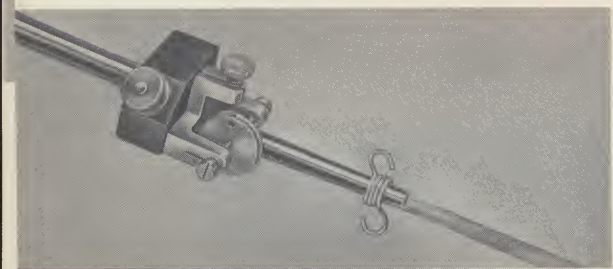
425-75 ROLLS 7½" wide x 135 yards long.

425-100 SHEETS 7¾" x 21½", pkg. of 100 sheets.

425-115 ROLLS 11½" wide x 125 yards long.

II. RECORDING INSTRUMENTS AND ACCESSORIES

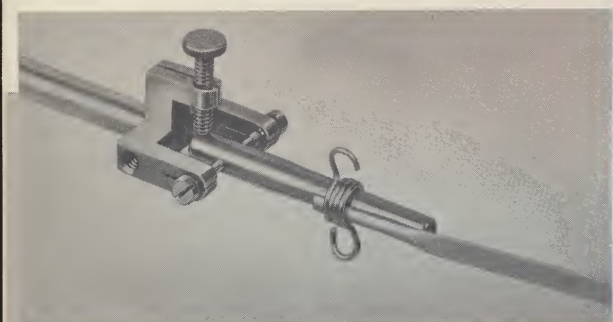
All Harvard Apparatus kymograph recording instruments are designed for either smoked drum or ink recording. In each instance, the instruments below are first described for the smoke writing application and are designated by the basic catalog number. Secondly, the instruments as designed for ink writing are designated by the catalog number followed by the suffix "INK". Also, kits for converting each smoke writing instrument to ink writing are designated by the catalog number followed by the suffix "INK KIT".



225 MUSCLE LEVER, LIGHT A pivoted lever for recording muscle contraction. A yoke supports an axle to which is attached a tapered metal tube and pulley. An insulating block, binding post and after-loading screw form the remainder of the lever. Furnished with aluminum stylus and double hook to which can be attached the muscle and scale pan.

225-INK MUSCLE LEVER, LIGHT Identical to 225 except that aluminum stylus is replaced by ink writing pen, bottle, etc.

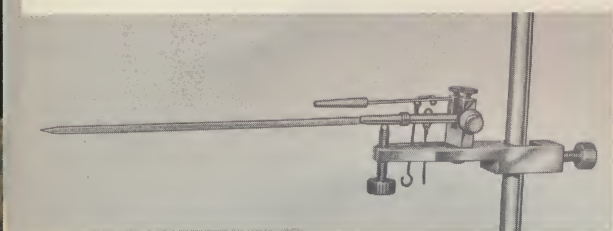
225-INK KIT Ink conversion kit for Light Muscle Lever.



226 SIMPLIFIED LIGHT MUSCLE LEVER Similar to 225 except for omission of pulley, insulated block and binding post.

226-INK Simplified Light Muscle Lever, Ink Writing.

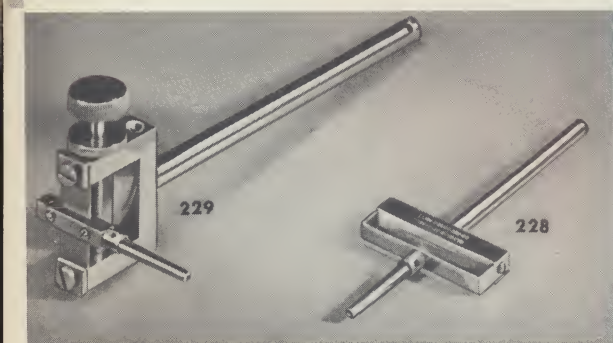
226-INK KIT Ink conversion kit for Simplified Light Muscle Lever.



227 MUSCLE LEVER, HEAVY Designed to bear weights up to one thousand grams. A steel spring is supplied that can be used for obtaining an isometric record. Furnished with special insulated double clamp (205).

227-INK MUSCLE LEVER, HEAVY Ink Writing.

227-INK KIT Ink conversion kit for Muscle Lever, Heavy.



228 LIGHT ISOMETRIC MUSCLE LEVER. Fixed spring and five-inch handle, supplied with aluminum stylus and wire ring.

228-INK LIGHT ISOMETRIC MUSCLE LEVER Ink writing.

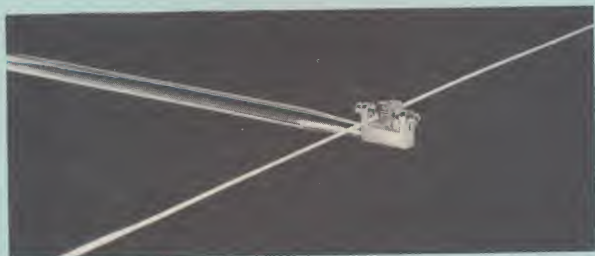
228-INK KIT Ink conversion kit for Light Isometric Muscle Lever.

229 HEAVY ISOMETRIC LEVER Heavy nicked brass yoke with tension adjusting knob. Furnished with four interchangeable springs of various degrees of stiffness and aluminum stylus with wire ring.

229-INK HEAVY ISOMETRIC LEVER Ink writing.

229-INK KIT Ink conversion kit for Heavy Isometric Muscle Lever.

HARVARD PHYSIOLOGICAL APPARATUS



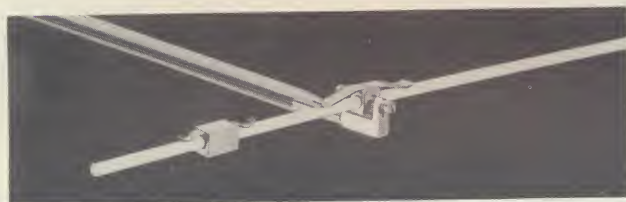
220 HEART LEVER ALUMINUM WIRE A basic heart lever, nicked brass, handle 15 cm. long. Fine conical pivots insure sensitivity. Aluminum wire stylus 22 cm. long can be held in any position by means of small check nut.

220-INK HEART LEVER Identical to 220 except that aluminum wire is replaced by ink pen. Supplied with bottle, clamp, etc.

220-INK KIT A complete kit to convert existing 220 heart levers into 220-INK.

221 HEART LEVER ALUMINUM TUBING Similar to the aluminum wire type except that hollow tubing is used. Supplied with two ten-inch swaged tubes that fit together to form a 20" lever. Sliding counterpoise included.

222 HEART LEVER WITH GRAVITY HEAD A complete heart lever with two sections of aluminum tubing and free swinging writing tip that rests against the paper by gravity. Extremely low friction and inertia for delicate recording.

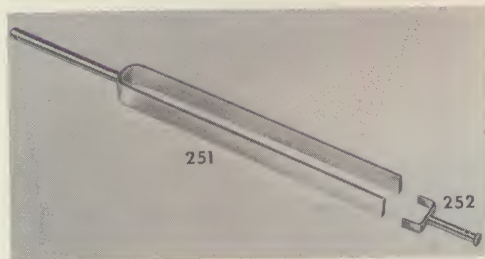
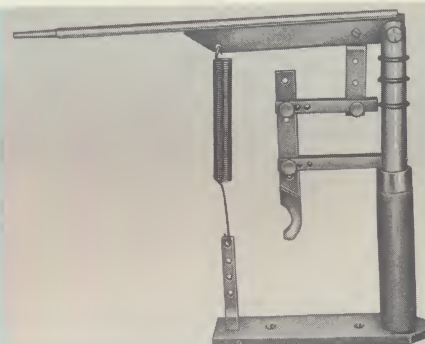


223 HEART LEVER, WOODEN STYLUS Similar to 221 except that a single polished wooden rod (applicator stick) 10" long is used in place of the aluminum tubing. Sliding counterpoise included.

260 ERGOGRAPH A trigger type ergograph with direct-writing tip. Nicked brass with soft rubber grip. Various adjustments can be made to vary tension and magnification. Drilled base for bench mounting.

260-INK Same as 260 except equipped with ink writer.

260-INK KIT Ink conversion kit for Ergograph.



251 TUNING FORK Nicked steel adjusted for 100 double vibrations per second. When pointer is attached, timing marks of one hundredth of a second can be obtained to measure latent period, etc.

251-INK TUNING FORK, INK WRITING

251-INK KIT Ink conversion kit for Tuning Fork.

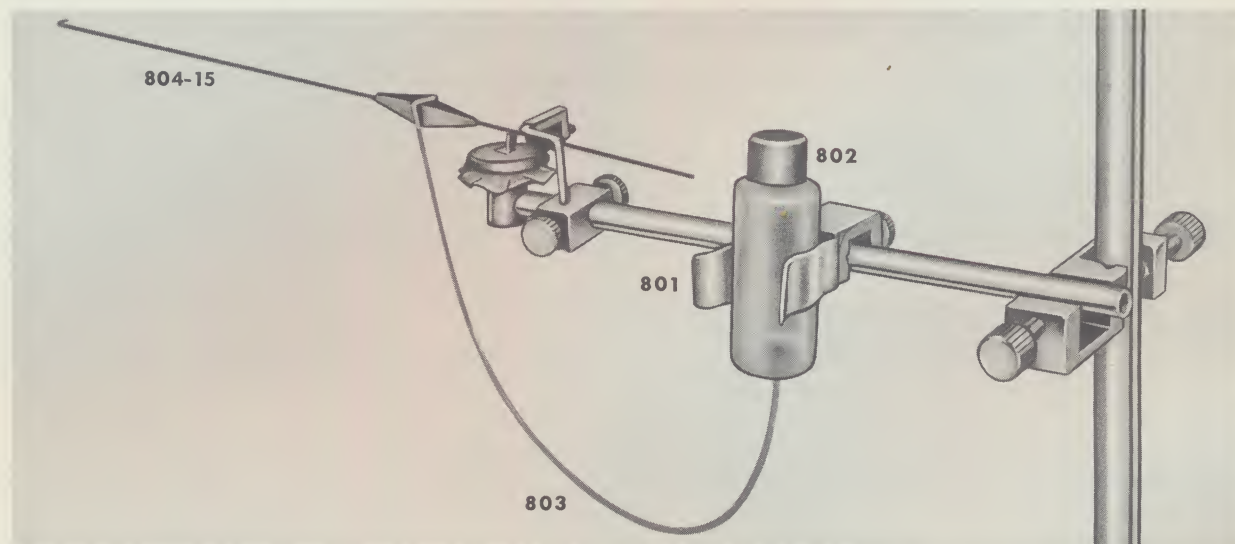
252 TUNING FORK STARTER A "U" shaped strip with handle used to place the prongs of the tuning fork in compression. When starter is removed, fork vibrates. Nicked brass, provided with binding post so that instant of break may be recorded.

R290 REPAIR KIT For various heart and muscle levers. Compartmented plastic case containing levers, yokes, axles, screws, etc.

INK WRITING INSTRUMENTS FOR KYMOGRAPH RECORDING

The ink writing system is composed of a stainless steel pen, ink tube, pressure spring and adapter, reservoir bottle and bottle holding clamp. The bottle is of soft polyethylene thereby allowing the ink to be forced to the pen tip under positive pressure by squeezing the bottle when the cap is tight. If the bottle is squeezed first with the cap loose, then the cap tightened and the bottle released, all of the ink can be withdrawn

from the pen and tube. This procedure eliminates the possibility of dried ink clogging the pen. The extremely fine pen tip provides a fine line as well as insuring adequate capillary action. A flexible steel spring allows the pen tip to always rest against the paper with proper pressure. The special unglazed paper required for ink writing is described on page 3.



610-INK, showing ink components for Sphygmograph Tambour

CONVERSION KITS

Ink writing conversion kits have been designed to fit each of our existing writing instruments. In each case it is only necessary to replace the conventional writing tip with the ink pen and adapter. The ink bottle clamp will fit the handles of all levers or can be fastened directly to the vertical stand rod. However, all ink

conversion kits are not interchangeable between all writing instruments.

Ink conversion kits are designated by the catalog number of the writing instruments to be converted followed by the letters INK KIT.

REPLACEMENT PARTS FOR INK SYSTEMS (refer to photograph above)

Part No.	Description
801	Bottle Holder Clamp and Screw
802	Ink Bottle, complete with Tubing and Cap
803	Ink Tubing only, sold by the foot

The above parts are common to all recording instruments except the Mercury Manometers and 625 Micro Spirometer.*

INK PEN and ADAPTERS*

Part No.	Writing Instrument(s) to be Adapted
804-11	220
804-12	225, 226, 227, 228, 229, 260
804-13	251, 322
804-14	602
804-15	609, 610
804-16	320

INK WRITING SUPPLIES

808 INK CLEANING WIRE for cleaning all ink pens.
Available by the foot.

815 INK, BLACK 8 oz. plastic bottle.

816 INK, RED 8 oz. plastic bottle.

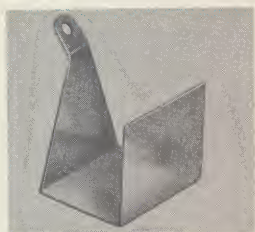
817 INK, GREEN 8 oz. plastic bottle.

*Ink system components for Mercury Manometers and 625 Micro spirometer are not available. Please refer to INK KITS on pages 8 and 9 for these instruments.

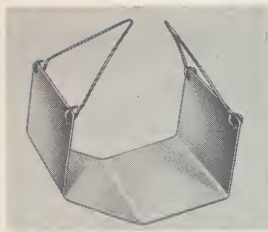


HARVARD PHYSIOLOGICAL APPARATUS

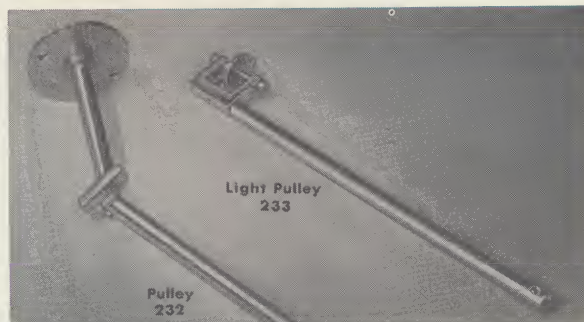
LEVER ACCESSORIES



230-S SMALL SCALE PAN Light aluminum with capacity of 10 ten-gram weights.



230-L LARGE SCALE PAN Aluminum with wire handles. Capacity 100 ten-gram weights.



232 LARGE JOINTED PULLEY Nicked brass with 32 mm. diameter pulley.

233 LIGHT PULLEY 13 mm. diameter pulley on pivoted axle held in yoke. Handle can be fastened to yoke in either of two positions.

231-5 FIVE-GRAM WEIGHTS Package of 10.

231-10 TEN-GRAM WEIGHTS Package of 10.

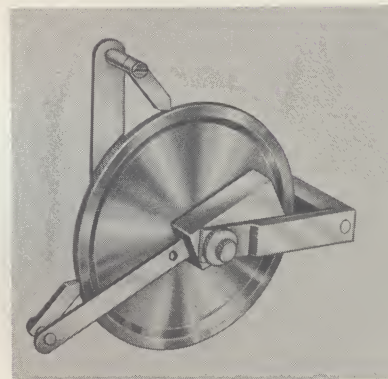
111 COLOPHONIUM CEMENT One-inch cubes of special low-melting wax used to fasten writing points to levers.



253 VOLUME TUBE Glass tube similar to plethysmograph tube. Provided with double-hole stopper in which are a capillary tube and muscle-holding wire. Used to demonstrate the virtually constant volume of contracting muscle.

317-T REPLACEMENT GLASS TUBE for #253, #317 and #620.

250 WORK ADDER (FICK) A small mechanical device to integrate random motion or work over a period of time. A notched aluminum wheel and pulley are on the same axle. Changes of motion cause the wheel to revolve by means of the lever and pawl resulting in a weight being raised by the pulley. The weight, multiplied by the height raised, is equivalent to the integrated work performed. Useful in the construction of "Jiggle Cages", etc.

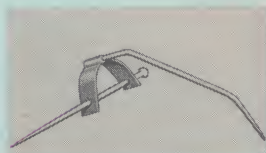


LEVER REPLACEMENT PARTS

220-W ALUMINUM WIRE STYLUS ONLY For replacement in Catalog #220 lever.

221-A ALUMINUM TUBING TWO SECTIONS, STYLUS ONLY For replacement in Catalog #221 lever.

222-AG ALUMINUM TUBING, TWO SECTIONS AND GRAVITY HEAD ONLY For replacement in Catalog #222 lever.



222-GH GRAVITY HEAD ONLY For replacement in Catalog #222 lever.

223-W WOODEN STYLUS ONLY For replacement in Catalog #223 lever.

223-C COUNTERPOISE ONLY For replacement in Catalog #221, #222, #223 levers.

225-ST FLAT ALUMINUM STYLUS ONLY For replacement in all muscle levers.

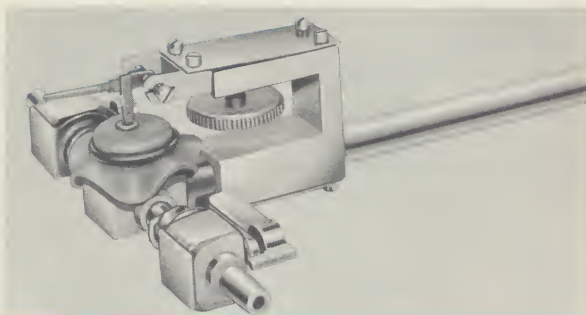


225-HK DOUBLE HOOK ONLY For replacement on all muscle levers.



225-WR WIRE RING ONLY Aluminum ring for replacement on all muscle levers.

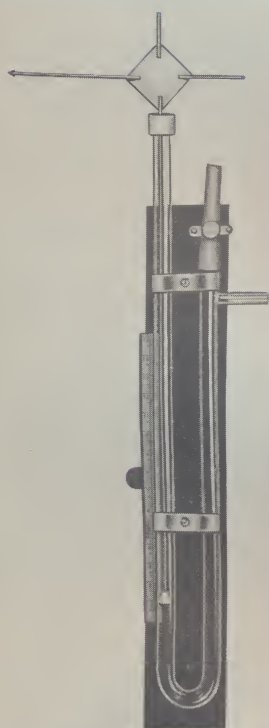
RECORDING MANOMETERS and TAMBOURS



602 MEMBRANE MANOMETER A small chamber sealed with a rubber membrane and two brass stopcocks. A lever system resting on the membrane magnifies and records pressure changes in the chamber. By virtue of its small size the manometer will record pressure changes of a rapidly beating ventricle at pressures up to 200 mm. of mercury. Supplied with assorted membranes.

602-INK MEMBRANE MANOMETER, INK WRITING

602-INK KIT Ink conversion kit for Membrane Manometer.



603-200 LARGE MERCURY MANOMETER A clear glass U-Tube mounted on a Bakelite block with hollow stainless steel, non-kinking, float rod. Supplied with mounting rod, sliding millimeter scale and compression clamp. Maximum pressure that can be recorded is 200 mm. of mercury.

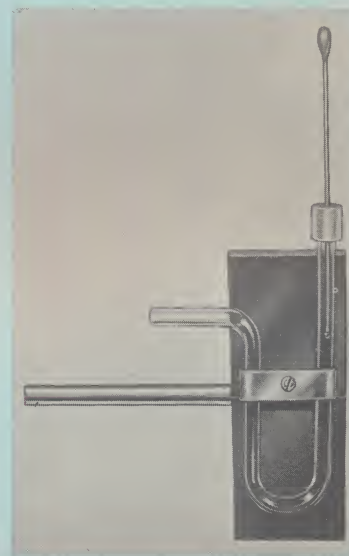
603-200-INK LARGE MERCURY MANOMETER, INK WRITING

603-200-INK KIT Ink conversion kit for Large Mercury Manometer.

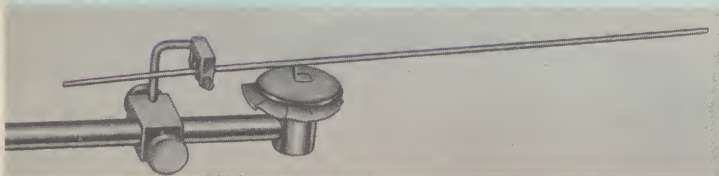
603-300 EXTRA LARGE MERCURY MANOMETER Similar to 603-200 but for longer length allowing the recording of pressures up to 300 mm. of mercury.

603-300-INK EXTRA LARGE MERCURY MANOMETER, INK WRITING

603-300-INK KIT Ink conversion kit for Extra Large Mercury Manometer.



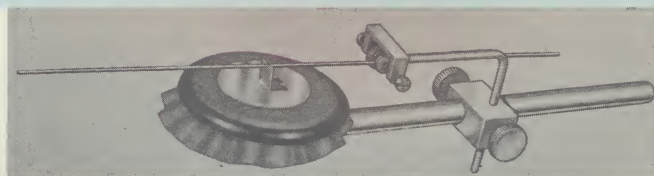
604 SMALL MERCURY MANOMETER Glass tubing on Bakelite back with recording stylus and mounting handle. For recording pressures up to 50 mm. of mercury. Suitable for recording blood pressures in the frog and turtle.



610 SPHYGMOGRAPH TAMBOUR Small and sensitive, this tambour permits pulse tracings from a thistle tube placed over the carotid artery. The volume pulse can be recorded when used with the 620 Plethysmograph tube.

610-INK SPHYGMOGRAPH TAMBOUR, INK WRITING

610-INK KIT Ink conversion kit for Sphygmograph Tambour.



609 MAREY TAMBOUR A nickered brass bowl 1 3/8" in diameter is sealed by means of a thin rubber diaphragm that responds to changes in pressure. A light adjustable magnifying lever transmits pressure changes to the recording drum. Thin diaphragm easily changed by use of neoprene "O" ring retainer.

609-INK MAREY TAMBOUR, INK WRITING

609-INK KIT Ink conversion kit to change 609 to 609-INK.



HARVARD PHYSIOLOGICAL APPARATUS

MANOMETER and TAMBOUR ACCESSORIES

601 GRADUATION TUBE (Pressure Calibration Device) A U-shaped glass tube filled with mercury with a rubber bulb and movable mm. scale. By compressing the bulb with the compression plate any desired pressure in mm. of mercury may be obtained. Useful in calibrating membrane manometers, strain gauges, or other pressure indicators.

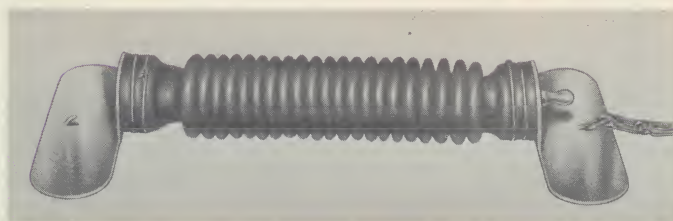
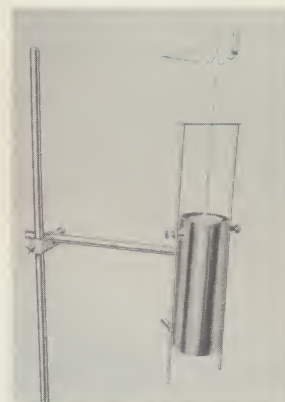


625 MICRO SPIROMETER

A very small spirometer with ultra light bell and no counterweight. Approximately 40 cc. capacity. Provided with mounting handle and two nozzles.

625-INK Micro Spirometer, Ink Writing.

625-INK KIT Ink conversion kit for Micro Spirometer.



605 PNEUMOGRAPH A molded corrugated neoprene tube and nicked brass end fitting. Designed to be fastened around chest or abdomen with chain. Pressure changes inside tube due to changes in length can be recorded with a Marey Tambour 609.



620 PLETHYSMOGRAPH TUBE

A glass tube as in the muscle warmer but with rubber collar. The middle finger is held airtight in the tube and the volume pulse can be recorded by means of the Sphygmograph Tambour 610.

317-T REPLACEMENT GLASS TUBE for #620, #253 and #317.

700 FROG BOARD A waxed hardwood operating board for frog experiments measuring 9" x 6" x 7/8". Six stainless steel clips supplied can be inserted into the holes to secure frogs of any size.

700-C REPLACEMENT FROG BOARD CLIPS



REPLACEMENT PARTS FOR MANOMETERS and TAMBOURS

602-M Set of replacement membranes and retainer ring only for use with 602 Membrane Manometer.

603-200-R Replacement Float Rod, cap, stylus and stylus holder only. For use only with 603-200 Manometer.

603-200-U Replacement Glass "U" Tube only for use with 603-200 Manometer.

603-300-R Replacement Float Rod, stylus and stylus holder complete. For use with 603-300 Manometer.

603-300-U Replacement Glass "U" Tube only for 603-300.

605-RB Replacement Neoprene Bellows and Chain for 605 Pneumograph.

609-D Replacement Rubber Diaphragm for 609 Tambour.

609-F Replacement Aluminum Float for 609 Tambour.

609-L Replacement Aluminum Writing Lever for 609 Tambour.

609-OR Replacement Neoprene "O" Ring for 609 Tambour.

610-D Replacement Rubber Diaphragm for 610 Tambour.

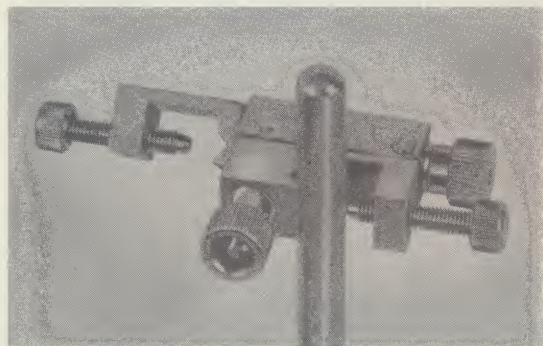
610-F Replacement Aluminum Angle Float for 610 Tambour.

610-L Replacement Aluminum Writing Lever for 610 Tambour.

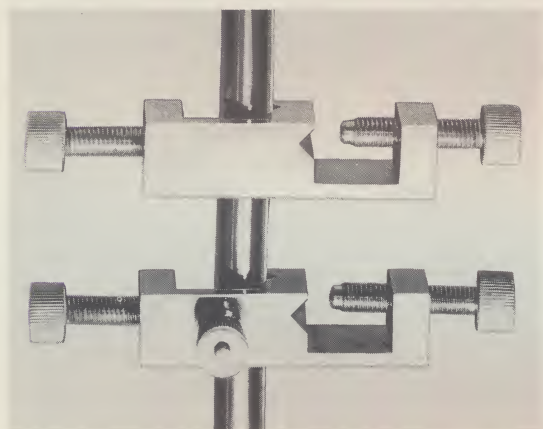
610-OR Replacement "O" Ring for 610 Tambour.

III. CLAMPS, STANDS AND RODS

CLAMPS

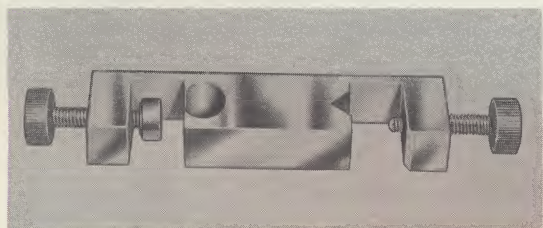


201 ADJUSTING CLAMP A swivel clamp with a slow-motion screw to bring instruments into gradual contact with the recording surface.

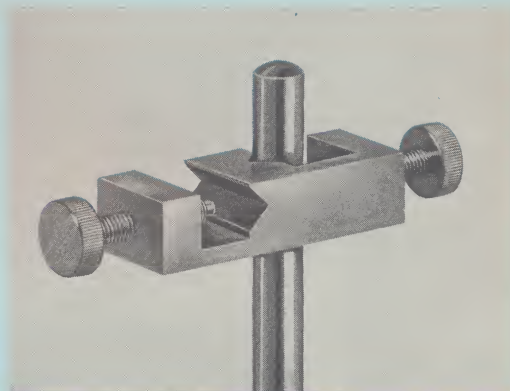


203 DOUBLE CLAMP Stainless steel to secure rods and instruments at precise right angles. $\frac{1}{2}$ " square stock. Capacity: 1 mm. to 14 mm. diameter.

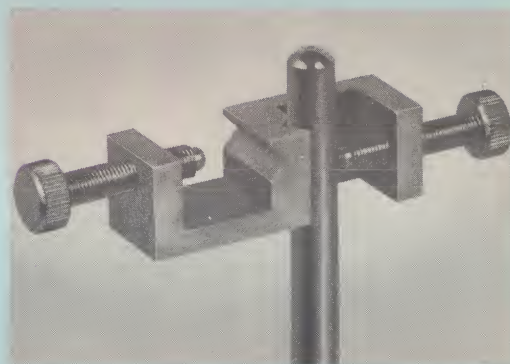
204 DOUBLE CLAMP WITH BINDING POST Same as 203 except for electric binding post.



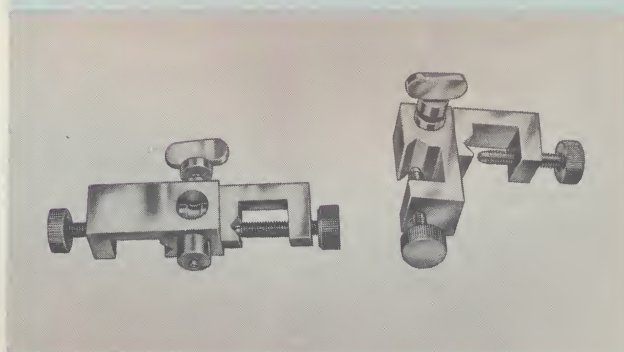
205 INSULATED CLAMP A nicked brass double clamp of $\frac{3}{4}$ " x $\frac{1}{2}$ " stock. One end completely insulated at points of contact.



206 DOUBLE CLAMP Intermediate size double clamp. Nicked brass, $\frac{3}{4}$ " x $\frac{1}{2}$ " stock with heavy screws.



207 DOUBLE CLAMP Large size double clamp. Nicked brass, $\frac{3}{4}$ " x $\frac{3}{4}$ " stock with heavy screws.



208 COMBINATION SWIVEL AND OFFSET CLAMP This new clamp is a combination swivel and offset swivel clamp. It easily separates into two pieces for assembly as either a swivel or offset clamp.



HARVARD PHYSIOLOGICAL APPARATUS

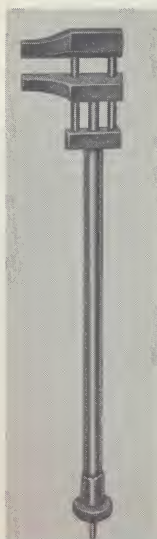


211 FLAT-JAWED FEMUR CLAMP

Nickel Brass. Two hinged, spring-loaded jaws closed by a thumbscrew. Jaws grooved to hold femur bone in nerve muscle preparation.

213 GASKELL CLAMP

Two open hard rubber jaws with bevelled edges operating on guide rods. The knob at the end of the handle moves the jaws to compress the muscle.

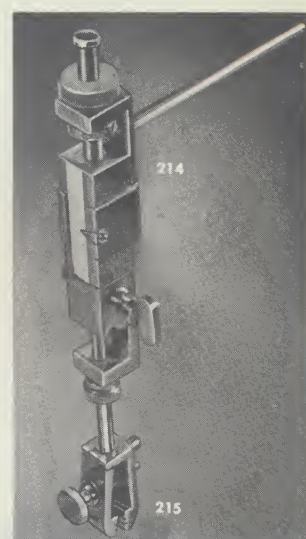


214 ISOMETRIC TENSION CLAMP

A clamp with a fine screw adjustment, pointer and mm. scale. Used to adjust accurately the initial length or tension of a muscle in isometric contraction experiments. Clamp can be used as shown or at right angles by detaching the lower, swiveled bottom section and reinserting. Furnished with knurled screw in lower member.

215 THREADED FEMUR CLAMP

A standard 211 Femur Clamp shortened and threaded to fit the Isometric Tension Clamp as shown.



STANDS



501 FLAT BASE STAND

Heavy steel base, stainless steel rod 45 cm. high. Offset base may be brought very close to kymograph:



502 ADJUSTING SCREW STAND

Same as Flat Base, but rod can be rotated by means of a fine tangent screw to bring points up to writing surface.

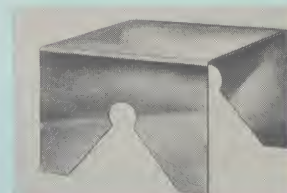


507 ADJUSTING SLEEVE

Sliding adjustments: height and rotation. Designed to fit rod of flat base stand so that group of instruments may be raised, lowered, or swung in relation to the drum.

506 ALUMINUM TABLE STAND

One piece aluminum 8" x 7" x 4". Useful for supporting kymographs, etc.



422 LEVELING TABLE

Nickel brass circular plate, 6½" diameter, with three leveling feet. Designed to fit the base of the spring kymograph to adjust its relation to the writing points. Useful for many purposes.

RODS

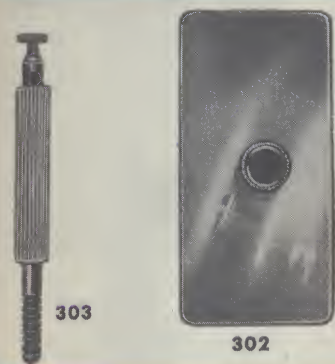
508 RIGHT ANGLE ROD ⅜" diameter, nickel brass 4 x 6 inches, allows apparatus to be placed in any desired position.

509 MOUNTING ROD, LIGHT 5 mm. diameter, 23 cm. long, nickel brass, circular grooves for tying threads. Useful as a light support.

510 MOUNTING ROD, TUBULAR 6 mm. bore, 24 cm. long, useful as a support and conduit for leading wires to instruments.

511 MOUNTING ROD, SOLID ⅜" diameter nickel brass by 24 cm. long. Useful as support or extension.

IV. ELECTRICAL APPARATUS

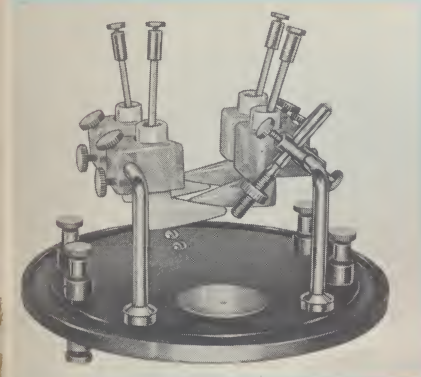


302 PLATE ELECTRODE (Indifferent) Nickered oblong brass plate, 3 x 6 cm., with binding post.

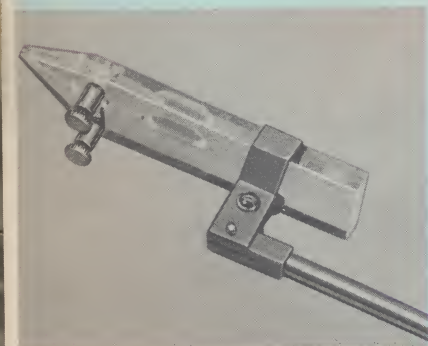
303 ROD ELECTRODE (Active) Nickered insulated brass rod 6 cm. long, ringed for cotton at one end, binding post at the other.



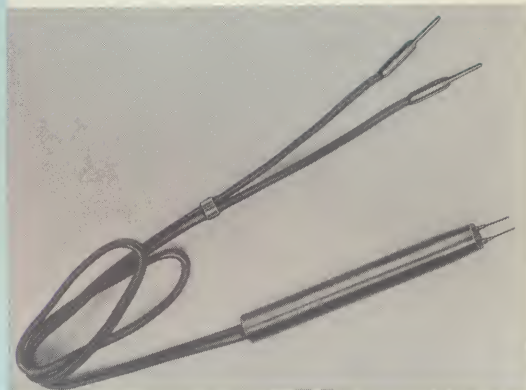
306 SHIELDED ELECTRODES A narrow plexiglass plate with a curved lip. A movable cover-plate enables the electrodes to be fastened to an exposed nerve in contact with the built-in platinum wires which are connected to the source of stimulating voltage.



314 MOIST CHAMBER A non-conducting plate 5 inches in diameter and transparent removable plastic cover 3 inches high. Supported on rods inside are four non-polarizable boot electrodes with holders and femur clamp. Four binding posts are provided, so that stimulating or muscle currents can be applied or recorded. Since the cover is relatively air-tight, a moist atmosphere is preserved in the chamber.



315 MOIST NERVE PLATE An adjustable plastic plate with groove for the nerve and a well for physiological solution. Electrodes are built into the groove for stimulation. Binding posts are included. Useful for many nerve muscle preparations, especially in study of blockage.

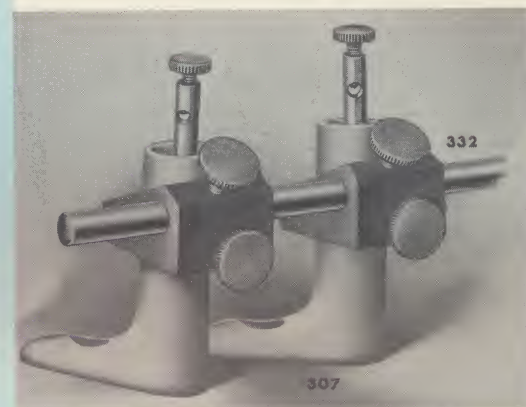


304 PLATINUM ELECTRODES Hand electrodes, molded handle, rubber covered wires 36" long with insulated terminals. Removable tips protrude 10 mm. Furnished with platinum tips.

304-Pt Platinum replacement tips, easily inserted.

305 SILVER ELECTRODES Same as 304 except with silver tips.

305-Ag Silver replacement tips.



307 BOOT ELECTRODES Unpolarizable, made with hollow unfired potter's clay with a well in the "instep". Supplied with zinc strips to which binding posts are attached.

307-ZINC Replacement zincs for 307 Electrodes.

332 HOLDERS FOR BOOT ELECTRODES Consists of mounting rod, plastic holders, binding posts and mounting screws.



HARVARD PHYSIOLOGICAL APPARATUS



316 PLATE, ADJUSTABLE GLASS This nerve holder is a 3 x 1 inch glass plate held by a spring clip attached to a lead wire which may be bent as desired. The moistened nerve on the plate can be held in any position relative to the muscle.

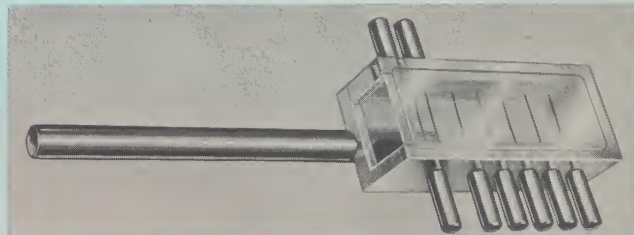


317 MUSCLE WARMER A device designed to warm a muscle to desired temperature by immersion in a water bath. The smaller bottom end is sealed with a cork. The upper end receives a brass disc assembly containing a mounting handle, muscle holding assembly and two access holes. The holes in the top permit insertion of thermometer and thread attached to the muscle. Furnished complete with tube, cork and disc assembly.

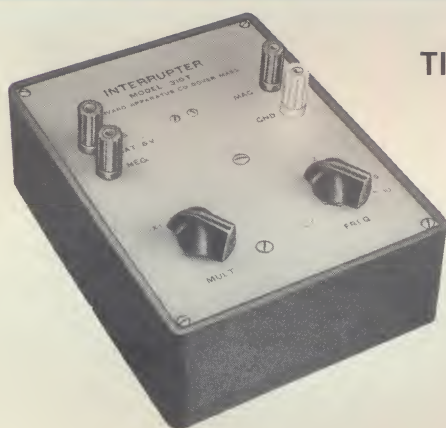
317-T REPLACEMENT GLASS TUBE for #317, #253 and #620.

318 NERVE CONDUCTION CHAMBER A clear plastic chamber with silver electrodes and glass cover for use with the sciatic nerve of the frog in various electro-physiological experiments. Inside dimensions: 70 mm. long x 23 mm. wide x 17 mm. deep. Top surface recessed to receive standard 1 x 3 glass slide. A total of 8 wire electrodes are available for either stimulation or pickup. Three electrodes are spaced 5 mm. apart and the balance are 10 mm. apart. Each electrode is fitted with a binding post that receives "banana" plugs.

318-Pt. Same as 318 except with platinum electrodes.

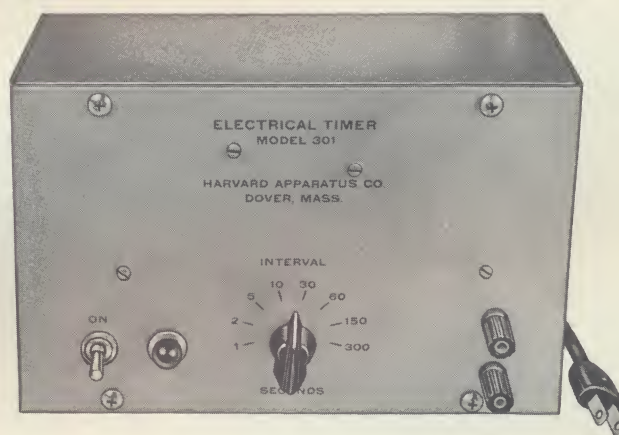


331 HOLDER FOR PLATINUM OR SILVER ELECTRODES A handle, lead rod, and clamp, to hold the plastic portion of Electrodes #304 and #305. Can be fastened and bent as desired.

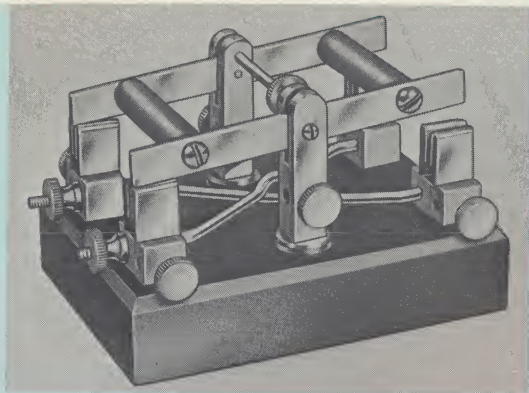


310-T TRANSISTORIZED INTERRUPTER A modern electronic version of the older vibrating interrupter. The new model features the use of transistors in an electronic circuit. In operation, Model 310-T will drive a signal magnet at any frequency between 1 and 100 pulses per second as selected by a calibrated dial. Unit requires external power supply of 4-6 volts D.C. Model 310-T is also useful as a source of accurate time base marks for use with oscilloscopes, etc.

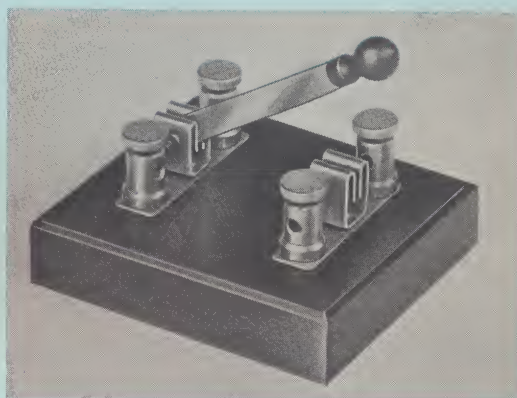
TIMERS, KEYS and MAGNETS



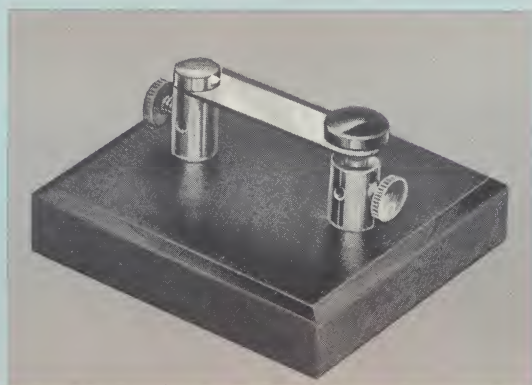
301 ELECTRICAL TIMER A central station timer for the generation of timing marks for use with Kymographic recording. Two synchronous motor driven timers produce eight rates with intervals of 1, 2, 5, 10, 30, 60, 180, and 300 seconds respectively. A rotary switch selects the appropriate rate. Heavy-duty 30 ampere contacts allow the unit to handle up to 25 signal magnets without the use of relays. Furnished complete with cord, pilot light, binding posts and etched panel. Standard units designed for 60 cycle voltage. Special units are available for 50 cycle use.



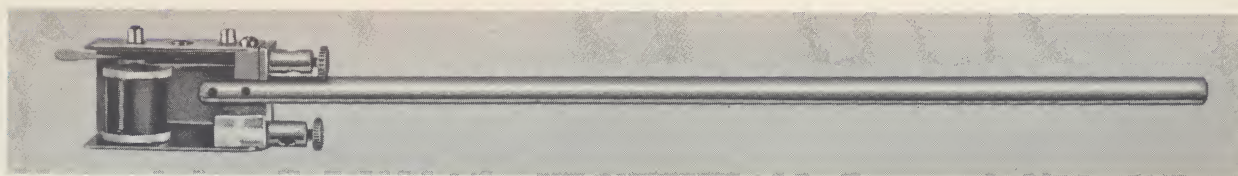
311 ROCKING KEY A double pole, double throw, pole-changing switch, flexible enough to be used in any circuit.



312 SHORT CIRCUIT KEY A single knife-type switch used to open or close a circuit.

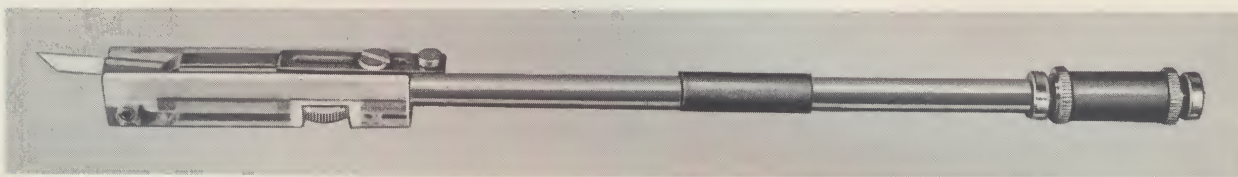


313 SIMPLE KEY A single-key momentary switch with fine silver contacts.



320 27 mm. SIGNAL MAGNET A simple, inexpensive electromagnet, used to record the opening and closing of a circuit, etc. Operates on $1\frac{1}{2}$ to 5 volts. Adjustments for armature position and excursion. Will follow records up to 100 double vibrations per second.

320-INK 27 mm. SIGNAL MAGNET, INK WRITING
320-INK KIT Ink conversion kit for 320 Signal Magnet.
R320 REPAIR KIT FOR 320 SIGNAL MAGNET Compartmented plastic case containing coils, vibrators, screws, etc.



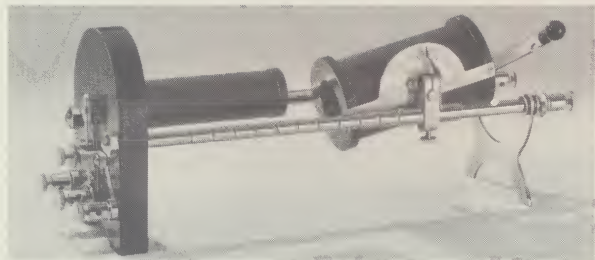
322 10 mm. SIGNAL MAGNET A versatile, advanced type of electro-magnetic marker operating on $1\frac{1}{2}$ to 10 volts. Serves as a sinusoidal wave recorded by means of adjusting to natural frequency of the interrupter. Points are fastened without gum or wax. The armature also operates silver contacts through small binding posts, thus acting as a relay to signal the opening and

closing of the circuit. This can be used as a make shock cut-out or can be used to run a second circuit. When used with a 60-cycle transformer, 60-cycle sine waves can be recorded as a timing device. (Sliding insulating sleeve and complete instructions furnished.)
322-INK 10 mm. SIGNAL MAGNET INK WRITING
322-INK KIT Ink conversion kit for 322 Signal Magnet.



HARVARD PHYSIOLOGICAL APPARATUS

STIMULATORS



308 INDUCTORIUM A sliding-coil type variable step-up transformer, used as a source of stimulation voltage. May be run on one or two dry cells. Furnishes simple make-and-break shocks or tetanizing currents of about 50 cycles per second. The voltage may be adjusted by the position of the secondary from zero to 2400 volts. Calibrated secondary tilt-protractor included.

R308 REPAIR KIT FOR 308 INDUCTORIUM Compartmented plastic case containing vibrators, contact screws, binding post screws, etc.

330-20 REPLACEMENT #2FBP BURGESS BATTERY for 330 Induction Stimulator.



330 INDUCTION STIMULATOR Consists of battery, vibrating transformer and controls enclosed in a molded compact instrument case. Similar in function to the Inductarium but offering easier operation and upkeep. Three voltage ranges of 0-5, 0-50, and 0-500 volts can be selected by a range switch. Each range is variable from zero to its maximum voltage by means of potentiometer. The vibrating points are pre-set at the factory and are sealed in the case. A lever switch selects either make and break operation or tetanizing shocks at 50 per second. A signal magnet circuit delivers 1½ volts when the key is depressed. Furnished with calibrated panel and long-life battery.



340 ELECTRONIC STIMULATOR A stimulator for general classroom use featuring a constant width pulse and transformer coupled output.

341 PULSE ADAPTER A miniature transistorized signal magnet driver circuit to plug into the signal magnet terminals of the 340 stimulator. When in operation the D. C. signal magnet output voltage is modulated to provide one signal magnet pulse with each stimulus output.

Description and Specifications:

115 volt A.C. operation

Blocking oscillator circuit with 12AU7 and 6X4 tubes. Constant width pulse of 400-500 microsecond duration. Continuously variable frequency control from one to 100 stimuli per second.

Output voltage divided into three variable ranges, 0-1.5V, 0-15V and 0-150V.

Output impedance — low range 100 ohms
mid range 1000 ohms
high range 6000 ohms

Selector key for single and multiple operation

1½ volt signal magnet driver circuit

Provisions for remote operation

Trigger pulse output of 15 volts synchronized with stimulus

Printed circuit

Steel case, engraved panel, pilot light, rubber feet and supplied with circuit diagram.

Bulletin available

342 ELECTRONIC STIMULATOR WITH BUILT-IN PULSE ADAPTER This new stimulator combines the Model 340 with the 341 pulse adapter all in one unit. All functions are identical to Model 340 except that a single signal magnet pulse is produced with each stimulus pulse.

PRICE LIST *All prices f.o.b. Dover, Mass., U.S.A.*

SECTION I — KYMOGRAPHS, RECORDERS & SUPPLIES

Cat. No.	Price	Cat. No.	Price	Cat. No.	Price	Cat. No.	Price
401-6	\$100.00	420-9	\$ 28.50	425-115	\$ 4.50	441-405-6	\$165.00
401-10	102.00	420-9-Wick	1.35	440-6	85.00	600-404-6	223.00
R-401	19.00	424-10	3.50	440-10	87.00	600-404-10	225.00
402-6	120.00	424-75	3.00	440-405-6	160.00	600-405-6	88.00
402-10	122.00	424-100	2.00/C	440-407	10.00	600-405-10	90.00
403	165.00	424-115	4.00	441-6	90.00	600-407	10.00
420-5	28.50	425-75	3.00	441-10	92.00		
420-5-Wick	1.25	425-100	1.75/C	441-407	10.00		

SECTION II — RECORDING INSTRUMENTS & ACCESSORIES

Cat. No.	Price	Cat. No.	Price	Cat. No.	Price	Cat. No.	Price
111	\$.10	227-INK KIT	\$ 7.00	602	\$ 22.00	610	\$ 7.50
220	3.00	228	4.00	602-INK	29.00	610-INK	14.50
220-INK	10.00	228-INK	11.00	602-INK KIT	7.00	610-INK KIT	7.00
220-INK KIT	7.00	228-INK KIT	7.00	602-M .....	.45	610-D .....	.05
220-W .....	.25	229	10.00	603-200	12.50	610-F .....	.10
221	4.50	229-INK	17.00	603-200-INK	17.50	610-L .....	.25
221-A	1.00	229-INK KIT	7.00	603-200-INK KIT	5.00	610-OR .....	.10
222	6.00	230-S .....	.75	603-200-R	1.50	620	1.00
222-AG	2.50	230-L	1.25	603-200-U	2.50	625	70.00
222-GH	1.50	231-5.....ten for .....	.90	603-300	17.50	625-INK	75.00
223	3.50	231-10.....ten for	1.00	603-300-INK	22.50	625-INK KIT	5.00
223-C .....	.75	232	4.00	603-300-INK KIT	5.00	700	3.00
223-W .....	.10	233	3.00	603-300-R	1.75	700-C .....	.15
225	6.00	250	25.00	603-300-U	3.00	801	1.50
225-INK	13.00	251	2.50	604	5.00	802 .....	.50
225-INK KIT	7.00	251-INK	9.50	605	6.50	803	per foot .04
225-HK .....	.15	251-INK KIT	7.00	605-RB	3.25	804-11 through	
225-WR .....	.10	252	1.25	609	8.50	804-16	5.00
225-ST .....	.25	253	2.50	609-INK	15.50	808	per foot .01
226	4.50	260	24.00	609-INK KIT	7.00	815	2.30
226-INK	11.50	260-INK	31.00	609-D .....	.10	816	1.65
226-INK KIT	7.00	260-INK KIT	7.00	609-F .....	.25	817	2.30
227	18.00	R-290	16.00	609-L .....	.25		
227-INK	25.00	601	20.00	609-OR .....	.15		

SECTION III — CLAMPS, STANDS & RODS

Cat. No.	Price	Cat. No.	Price	Cat. No.	Price	Cat. No.	Price
201	\$ 12.00	207	\$ 3.00	215	\$ 5.00	507	\$ 5.00
203	1.75	208	6.00	422	13.00	508	1.20
204	2.00	211	5.00	501	4.00	509 .....	.50
205	3.70	213	7.50	502	12.00	510 .....	.80
206	2.75	214	15.00	506	3.50	511 .....	.90

SECTION IV — ELECTRICAL APPARATUS

Cat. No.	Price	Cat. No.	Price	Cat. No.	Price	Cat. No.	Price
301	\$ 85.00	307-Zinc	\$.50	316	\$ 5.00	322	\$ 18.50
302	1.00	308	32.50	317	5.00	322-INK	25.50
303 .....	.75	R-308	12.00	317-T .....	.75	322-INK-KIT	7.00
304	3.75	310-T	42.50	318	13.50	330	36.00
304-Pt .....per point .....	.75	311	16.00	318-Pt	25.00	330-20	1.65
305	3.05	312	5.00	320	6.50	331	5.00
305-Ag .....per point .....	.40	313	3.00	320-INK	13.50	332	1.00
306	12.00	314	22.00	320-INK KIT	7.00	340	80.00
307	1.00	315	8.00	R-320	6.00	341	22.00
						342	100.00

For Complete Catalog, write to:

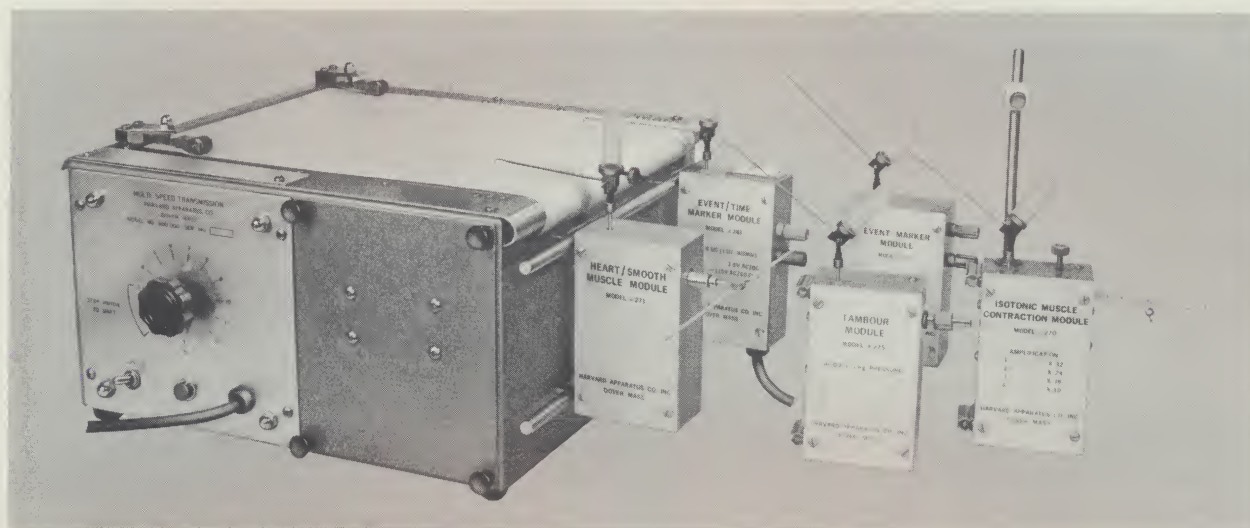


HARVARD APPARATUS CO., INC. • Dover, Mass., 02030

Tel: 617-785-0700

EXPORT ONLY: Box 146, Wellesley, Mass., U.S.A. 02181

MECHANICAL MODULAR RECORDING SYSTEM



INTRODUCTORY NOTES

Having built the first commercially available kymograph in this country back in 1880, we feel well qualified to talk about the problems of kymographic recording. The tried and true smoke-writing method still remains after, some eighty years, a simple and reliable way to make a permanent record. The kymograph is a hardy instrument; the smoke-writing levers are about as simple as you can get. Practically anyone can produce a satisfactory recording. That is, anyone who has the patience to fiddle around with some rather ticklish adjustments and who doesn't mind a little black soot. While smoke writing is simple, quite a bit of time is eaten up before a good record is achieved. Ink writing is somewhat more neat and clear but still requires considerable technique and patience.

After some years of listening to the complaints of both teachers and students, we plunged into the problem and came up with a new system of recording. We took a close look at a typical kymograph set-up and found that the major difficulty was in getting a writing tip (either smoke or ink) to rest against the curved surface of the drum with just the right pressure. Furthermore, a great deal of supporting apparatus was needed in addition to the levers themselves. The height of each lever and its proximity to other levers posed more problems. All this necessitated a great deal of adjustment that was not only causing a lot of aggravation but was using up valuable teaching and research time that could never be recovered.

We saw that by having all writing tips rest against horizontal paper by gravity the bulk of the adjusting problems would be solved. Ink writing was selected because new developments allowed us to make an ink pen that would not clog and that would be replaceable. Each separate lever was then built into a small box which we called a module. All adjustments are made here in our factory and sealed in against prying fingers. The only external parts are the ink pen and bottle, plus appropriate devices to connect the lever to the preparation and to other apparatus.

INDEX

1

HARVARD APPARATUS CO., INC.

(a non-profit organization)



INTRODUCTORY NOTES (Cont.)

We developed a variety of horizontal chart movers with mounting rods on the side to hold the spring clips on the modules. Each module just snaps onto any chart mover and is instantly ready to record. The modules are narrow enough so that five of them can be used at the same time on the same chart mover. Because of controlled dimensions, all five pens will line up perfectly and rest on the paper with just the right pressure for good recording

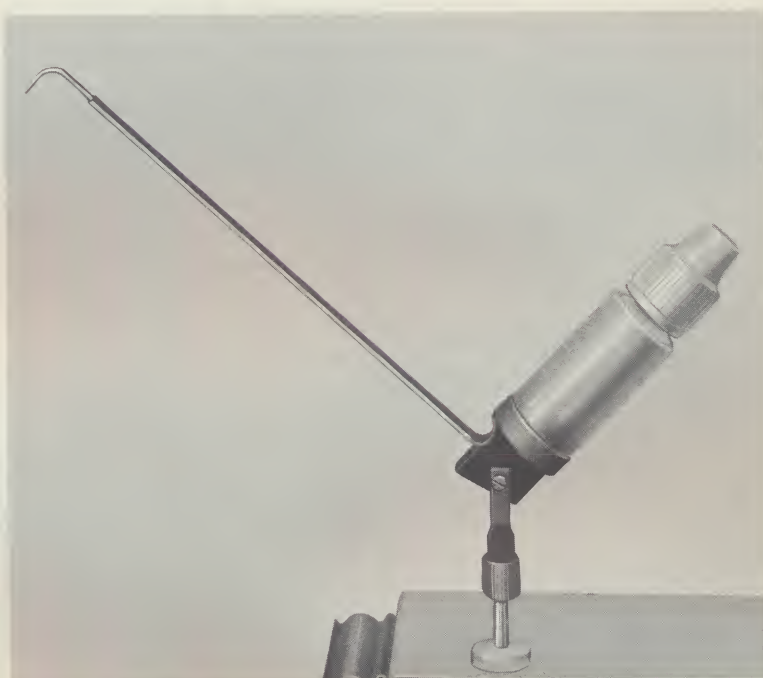
We now offer five different recording modules, each performing a specific function:

- Isotonic Muscle Contraction Module
- Heart and Smooth Muscle Module
- Tambour (respiration) Module
- Event Marker Module
- Event/Time Marker Module

To round out the system we stock both unlined and millimeter grid chart paper ruled in an attractive shade of green in sizes to fit all of our chart movers.

The new system was given a rugged test in a high school class accustomed to kymograph work. This preview delighted students and teacher alike. As anticipated, the biggest advantage of the system was in saving preparation time. For example, a frog heart preparation took six minutes from the live frog to the finished record. Other set-ups were equally as quick. Differences in individual techniques are minimized, resulting in more uniform records from group to group. In one of our tests, an inexperienced student was able to obtain a nicer looking heart recording than the teacher who was using a kymograph.

THE INK SYSTEM



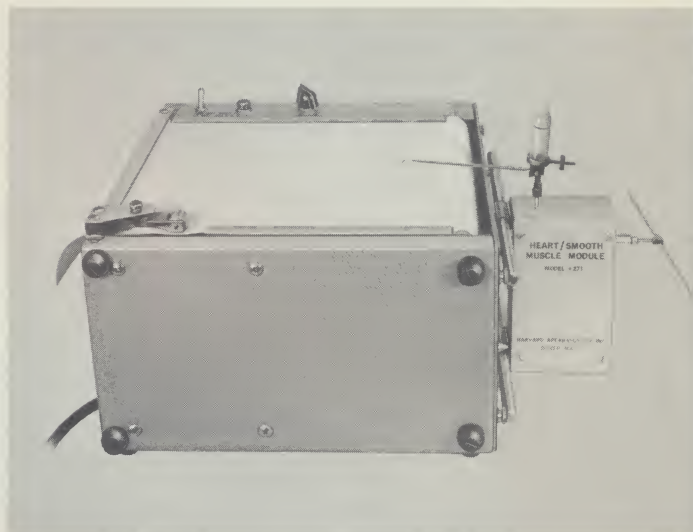
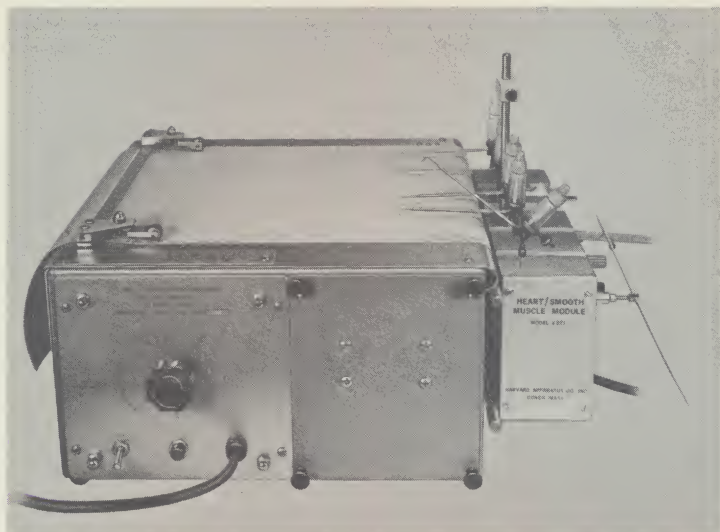
The writing pen and its ink bottle are combined in a one-piece assembly which snaps into place on each recording module. The assembly is so balanced that the pen tip always rests against the paper with the correct pressure, yet can be tilted up to stay in a non-writing position.

The construction of the assembly allows the ink to be completely withdrawn from the pen, thus minimizing clogging. This is done by loosening the bottle cap and squeezing the soft polyethylene bottle, then tightening the cap and releasing the bottle. Thus no ink can dry in the pen. To force ink back into the pen, just squeeze the bottle with the cap tight, then loosen the bottle cap.

Since pen assemblies can be changed with ease, different colored inks can be used and interchanged rapidly. Both red and black ink crystals are available.

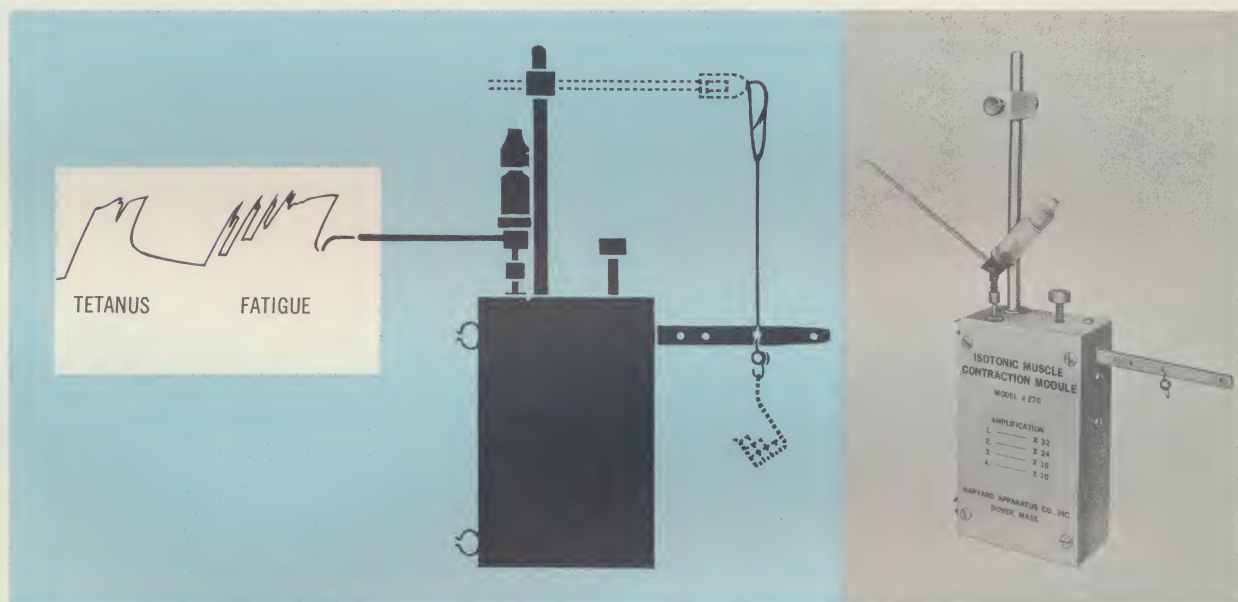


HARVARD PHYSIOLOGICAL APPARATUS



THE MODULES

The sealed box of each module measures 3" x 5" x 1½" and is finished with a Polyvinyl Chloride paint in Harvard Apparatus blue. The front panel is an anodized aluminum plate on which is listed the name of the module, its catalog number, specifications and, of course, our name.



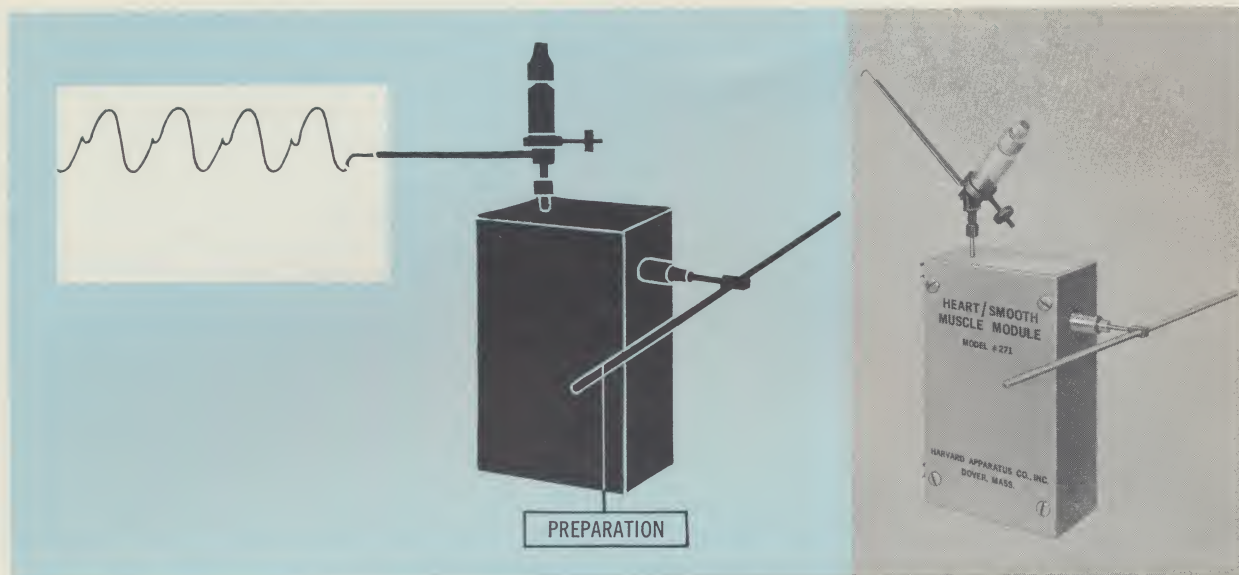
270 ISOTONIC MUSCLE CONTRACTION MODULE

Designed to record skeletal muscle contractions from the usual gastrocnemius preparation, this module is equipped with a vertical stainless steel rod fitted with a plastic, non-conducting clamp for holding our Model 211 Femur Clamp. Extending out from behind the module is an aluminum lever bar to which are attached the muscle and the weighted scale pan.

To assist the user we have calibrated the mechani-

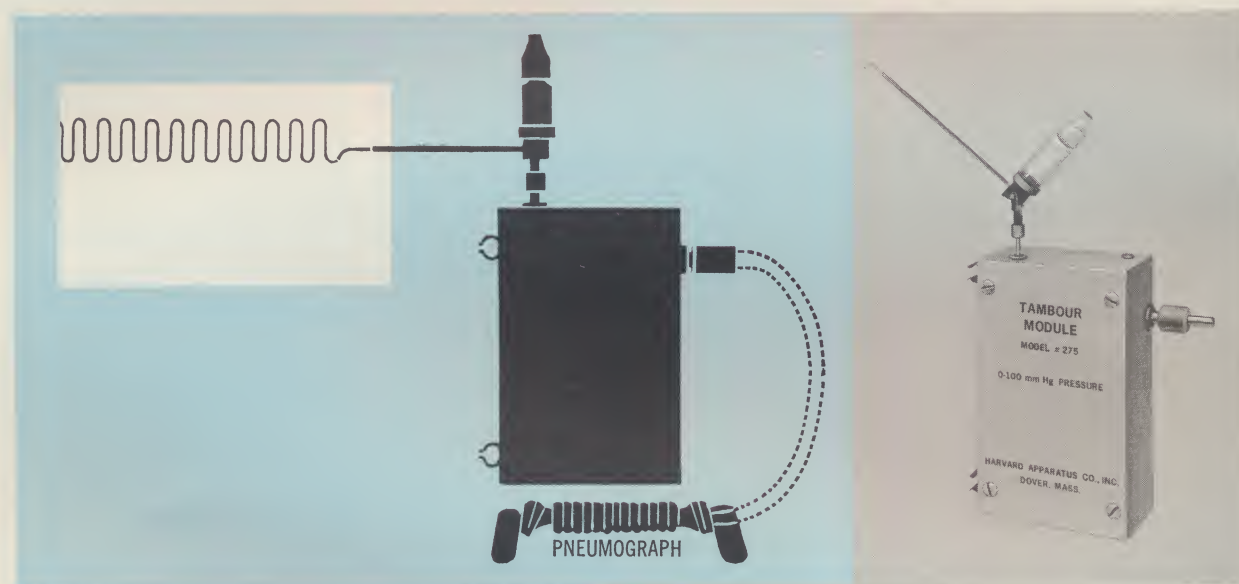
cal advantage of the module so that it is no problem to measure the record and tell exactly how much the muscle contracted. This worked out so well that we included four positions along the lever bar for different degrees of amplification and noted them on the front panel. They are: 10X, 16X, 24X, 32X.

The module is furnished with the rod, insulating clamp, lever bar and double hook for holding the scale pan. An after-loading screw is also provided.



271 HEART AND SMOOTH MUSCLE MODULE This turned out to be the most difficult unit to perfect. Extremely low friction of both internal components and pen tip were needed. Liberal use of ball bearings solved the first problem; a counterbalanced pen solved

the second. We use a removable standard wooden applicator stick as the moving lever, to which the preparation is attached. A tiny slip clutch protects the entire mechanism.



275 TAMBOUR (respiration) MODULE This is really a version of the old Marey Tambour all dressed up for modern recording with a host of new improvements. For years we have been using gum rubber diaphragms on tambours. These work fine and are very sensitive, but in a few years they dry out and have to be replaced. Our new tambour module uses a thin diaphragm of neoprene, guaranteed not to deteriorate. We also built in a little valve that will

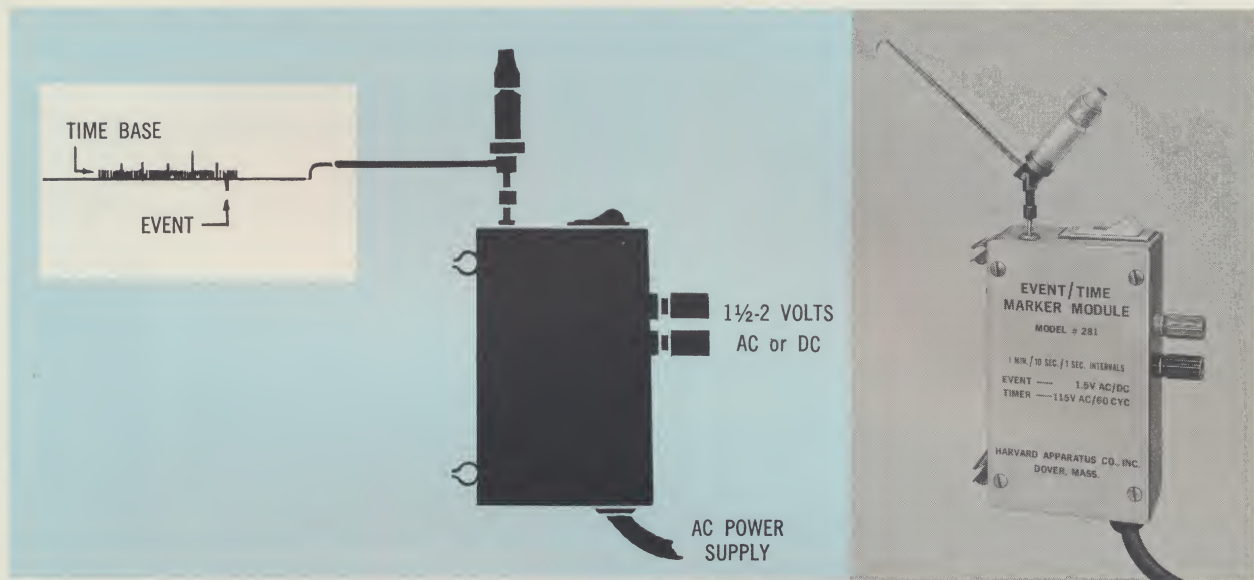
equalize air pressure once the pneumograph is hooked up to the module.

As in the other modules, there are no adjustments to make. Just hook up the tube from the pneumograph and record away.

As a side line, we have been using this tambour module as a pressure recorder to test new respiration pumps since it will record air pressures up to 100 mm. Hg. It even works with water!



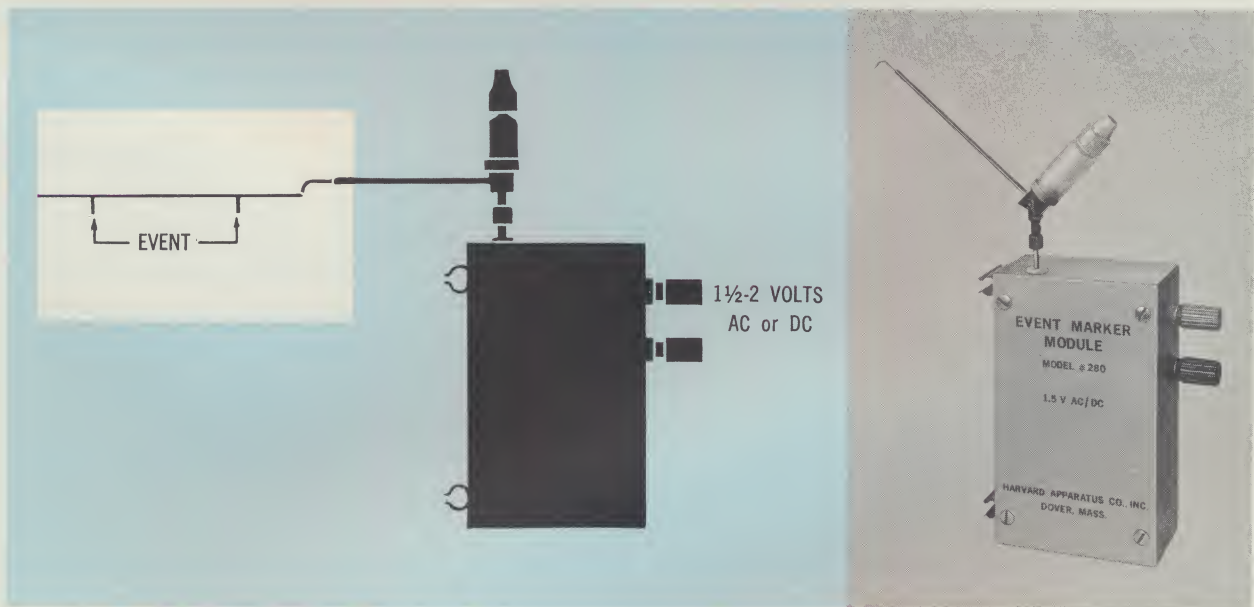
HARVARD PHYSIOLOGICAL APPARATUS



281 EVENT/TIME MARKER MODULE This module combines the function of a signal magnet with a continuous time base. Tucked inside the box is a small 1 R.P.M. synchronous motor which drives a timing wheel into which are sixty cuts of three depths. When the external AC power cord is plugged in and the switch on top of the module is depressed, the pen will produce time base markings directly on the re-

cording paper. These consist of vertical lines in 1 second, 10 second, and 60 second intervals, the longest line being the 60 second mark, the shortest being the 1 second mark.

At the same time, if a $1\frac{1}{2}$ volt AC or DC signal is applied through the terminals on the side of the module, the pen will deflect downwards producing an event mark.



280 EVENT MARKER MODULE This takes the place of a signal magnet, being practically identical to Model 281 except that no time base is provided. The

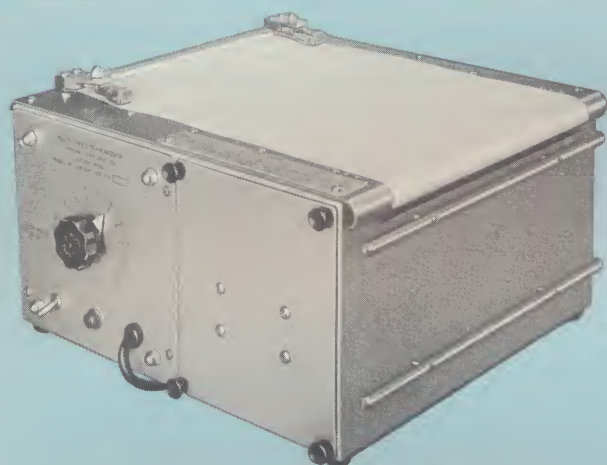
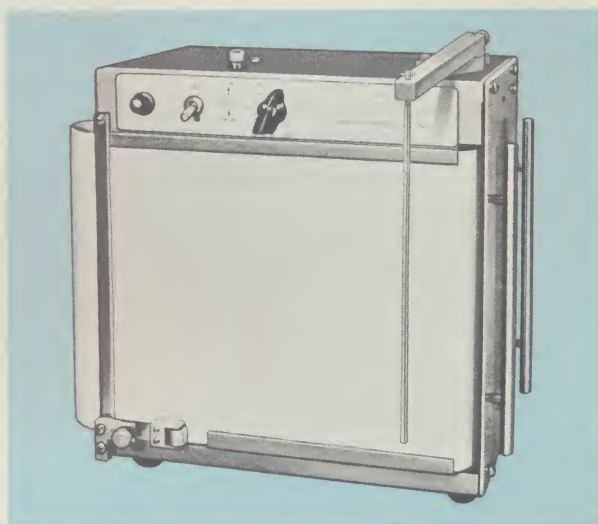
introduction of a $1\frac{1}{2}$ volt AC or DC signal through the terminals will cause the pen to deflect whenever an event is to be recorded.

CHART MOVERS

Since all modules record only on the horizontal plane, they can not be used with kymographs. Therefore, we offer four varieties of chart movers which can operate horizontally.

450 CHART MOVER This is the least expensive of the chart movers and accepts 8" wide paper either plain or ruled. A variable-speed motor, electronically controlled by a 6-position switch and a dual gearshift, permits selection of 12 speeds over a range of approximately 200-1. Speeds can be changed while in operation. Paper speeds range from 2100 mm./min. to 10 mm./min. Model 450 can be used either horizontally or vertically. Speed accuracy is better than $\pm 5\%$.

451 CHART MOVER This model is identical to 450 except that all speeds are reduced by a factor of 10, resulting in paper speeds from 220 mm./minute to 1.3 mm./minute. Model 451 is suitable for long-term recording of slow events.



850 CHART MOVER This model features a synchronous motor and 12-position gearbox allowing the instantaneous selection of 12 exact paper speeds from 12.5 cm./second to 0.0025 cm./second. It measures 15" long, 9" high, and 14" wide; weight is approximately 30 pounds. Model 850 is designed to accept 10" wide recording paper, either grid or unlined. A double-roll drive assures that the paper tracks properly and remains flat for good ink recording. Since this unit is especially designed for use with our modules, it operates only in the horizontal position. The chart mover comes equipped with rods for mounting the modules, five of which can be accommodated at once. Insertion

800 CHART MOVER Similar in appearance to Model 850, this is a bit larger and more complex, taking 10" wide rolls of either plain or ruled paper. The paper drive consists of a 12-position gearbox driven by a synchronous motor. The paper speed knob selects any of 12 speeds over a 5000 to 1 range from 25 cm./

of recording paper is easily and quickly made through the front of the chart mover so that the modules are not disturbed.

Model 850 Paper Speeds

Knob Position	Paper Speed cm./sec.	Knob Position	Paper Speed cm./sec.
1	12.5	7	.125
2	5	8	.0625
3	2.5	9	.025
4	1.25	10	.0125
5	.625	11	.00625
6	.25	12	.0025

Provision has been made for Model 810 Automatic Paper Take-up Roller.

Knowing that the user will want a number of power outlets to supply auxiliary apparatus, levers, stimulators, etc., we have made provision on the back of the chart mover for the installation of Model 851 Convenience Outlet Accessory.

851 CONVENIENCE OUTLET ACCESSORY Consists of a finished metal plate and four 3-wire grounded, fused outlets. A color-coded cord connects to a terminal strip in the chart mover. The power to the outlets is factory-wired through the main switch on the chart mover.

second to 0.005 cm./second. This unit has also been designed to operate either horizontally or vertically.

A swinging instrument arm is built onto the chart mover as an aid to the positioning of conventional levers in vertical operation.



HARVARD PHYSIOLOGICAL APPARATUS

ACCESSORIES

450-407 SWINGING INSTRUMENT ARM This handy little device attaches to the side of Models 450 and 451 and is used to hold conventional levers in vertical recording. It is made of aluminum and stainless steel and has double pivots.

810 AUTOMATIC PAPER TAKE-UP ROLLER For Models 800 and 850, this device fastens to the end of the chart mover and automatically winds up the paper regardless of recording speed. It consists of a small electric motor which drives a paper spool.

811 AUTOMATIC PAPER TAKE-UP ROLLER This is similar to Model 810 except that it accepts 8" wide paper and is used with Models 450 and 451.

851 CONVENIENCE OUTLET ACCESSORY for Model 850 Chart Mover.

852 PEN LIFTER BAR for use with Model 850.

SUPPLIES

425-8 INK WRITING PAPER, plain, roll 8" wide x 125 yards long, for Models 450 and 451 only.

426-8 INK WRITING PAPER, millimeter grid, roll 8" wide x 200 yards long for Models 450 and 451 only.

425-10 INK WRITING PAPER, plain, roll 10" wide x 125 yards long for Models 800 and 850.

426-10 INK WRITING PAPER, millimeter grid, roll 10" wide x 200 yards long for Models 800 and 850.

815 INK, BLACK, 8 oz. plastic bottle.

816 INK, RED, 8 oz. plastic bottle.

817 INK, GREEN, 8 oz. plastic bottle.

285-2 REPLACEMENT INK ASSEMBLY, consists of ink pen and bottle.

INSTRUCTION BOOK

In order to see our new modular recording system off to a good start, we have prepared a rather detailed "Manual of Operation and Application" for the system. Included are detailed technical explanations and specific directions for performing many of the more popular experiments. Also given are formulae for Ringer's solution and ink, plus helpful tips on recording techniques. The Manual is furnished at no extra charge with orders for two or more modules.

ELECTRONIC MODULAR RECORDING SYSTEM

Compatible with the mechanical recording system described here, we have developed an electronic recording module, bio-amplifier and mechanical-to-electric transducers which allow recording of bio-electric signals as low as 10 millivolts (EEG and EKG). See our Bulletin 350 or Catalog RS-4.

FUTURE DEVELOPMENTS

Although the five modules described in this Bulletin are mainly designed for physiological use, the chart movers can find many other uses. We are currently working on modules that will record a wide variety of physical phenomena including temperature, blood pressure, isometric contraction, etc. In addition, a 16-inch Chart Mover is under development.

PRICE LIST

MECHANICAL MODULES

270	Isotonic Muscle Contraction Module	\$ 51.00
271	Heart and Smooth Muscle Module	58.00
275	Tambour (respiration) Module	46.00
280	Event Marker Module	35.00
281	Time Base/Event Marker Module	64.00

CHART MOVERS

450	Horizontal/Vertical Chart Mover, 8" Paper, Standard Model	150.00
451	Horizontal/Vertical Chart Mover, 8" Paper, Slow-Speed Model	155.00
800	Horizontal/Vertical Chart Mover, 10" Paper Size	315.00
850	Horizontal Chart Mover, 10" Paper Size	275.00

At slight additional charge, Chart Movers can be modified to accept popular types of folding papers.

ACCESSORIES

285-2	Replacement Ink Assembly	13.00
450-407	Swinging Instrument Arm only for #450 and #451	10.00
810	Automatic Paper Take-up Roller only for #800 and #850	70.00
811	Automatic Paper Take-up Roller only for #450 and #451	70.00
851	Convenience Outlet Accessory for #850 only	8.50
852	Pen Lifter Bar for #850 only	8.50

SUPPLIES

425-8	Ink Writing Paper, plain, roll, 8" wide x 125 yards long for #450 and #451	3.25
425-10	Ink Writing Paper, plain, roll, 10" wide x 125 yards long for #800 and #850	4.00
426-8	Ink Writing Paper, millimeter grid, roll, 8" wide x 200 yards long for #450 and #451	7.00
426-10	Ink Writing Paper, millimeter grid, roll, 10" wide x 200 yards long for #800 and #850	7.25
815	Ink, black, 8 oz. plastic bottle	2.30
816	Ink, red, 8 oz. plastic bottle	1.65
817	Ink, green, 8 oz. plastic bottle	2.30

All prices f.o.b. Dover, Mass.

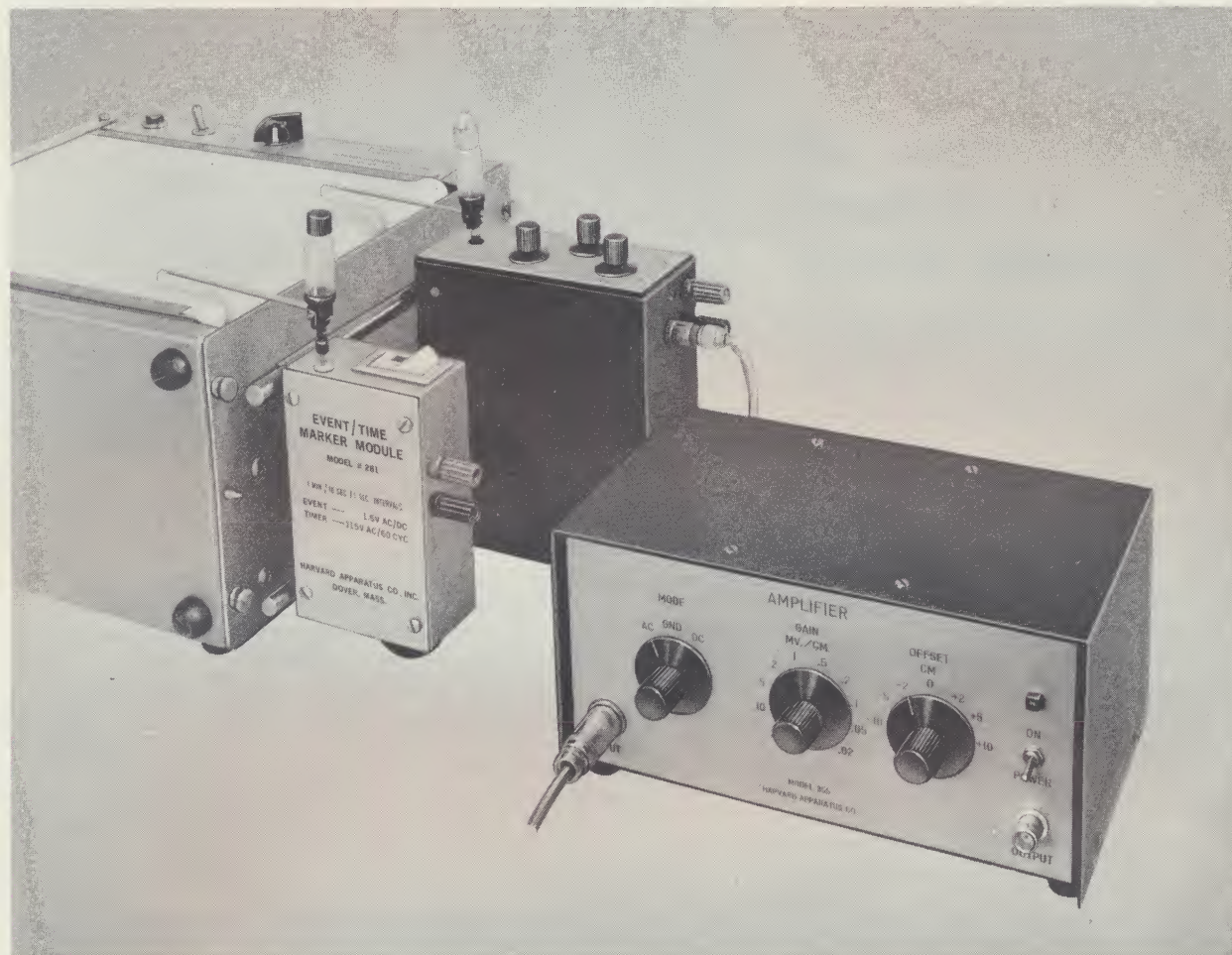


HARVARD APPARATUS CO., INC. • Dover, Mass., 02030

Tel: 617-785-0700

EXPORT ONLY: Box 146, Wellesley, Mass., U.S.A. 02181

MODULAR ELECTRONIC RECORDING SYSTEM



INDEX

1

To further the aims of Harvard Apparatus Co., Inc., in advancing teaching and research in physiology by the manufacture of low cost, quality apparatus, the Company now offers a *low cost* modular type of electronic recording system to complement the mechanical modules described in Bulletin 270. In developing the entire recording system, we felt that by having both electronic and mechanical modular elements, we could offer the user lowest cost and greater flexibility. Applications in which there is adequate energy can be most economically performed with the mechanical modules (tambours, skeletal muscle, etc.), while those applications requiring high electrical or mechanical amplification can best be performed electronically (EKG, EEG, smooth muscle, etc.)

By making both mechanical and electronic modules

small and instantly detachable, a complete system mixing both types of modules can be set up in seconds. Since electronic modules are complete with internal amplifiers and power supply, a system can be built up over a period of time minimizing initial outlay.

Any of our four standard chart movers can be used with any electronic or mechanical module, allowing even greater flexibility.

In summary, the new electronic/mechanical modular recording system is designed to bridge the gap between the older kymograph recording system and the new research polygraph systems. The best elements of both have been combined in a modular low cost system capable of easy expansion. The familiar use of levers should make the transition to the new system easy and pleasant.

A non-profit Organization
for the Advancement of
Research and Laboratory
Teaching in Physiology
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DOVER, MASSACHUSETTS 02030

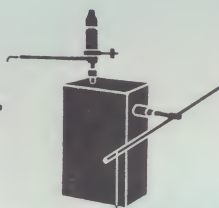
SPECIFICATIONS OF MODEL 350 ELECTRONIC RECORDING MODULE

- ELECTRONICS:** Solid state throughout amplifier and power supply
- FREQUENCY RESPONSE:** 0-25 cps ± 0.5 db
- SENSITIVITY, MAXIMUM:** 0.1 volt per 2.5 cm. pen deflection
- INPUT IMPEDANCE:** 100,000 ohms
- INPUT SIGNAL:** Either AC or DC
- MAXIMUM PEN EXCURSION:** ± 2.5 cm.
- INTERNAL CALIBRATION:** 0.1 volt reference source
- POWER OUTPUT:** Built into module — 15 volts DC regulated to power either Model 352 Transducer or Model 355 Bio-Amplifier
- GAIN:** Continuously variable from 0 to full sensitivity
- OPERATING CONTROLS:** Three, mounted on top panel —
Mode Control — 3 positions
 CAL — Connects amplifier to internal 0.1 volt reference signal for calibration
 GND — Ground amplifier input
 INPUT — Connects amplifier to input signal
Gain — Adjusts amplitude of pen excursion
Offset — Positions pen a maximum of ± 2 cm. either side of center line
- POWER REQUIRED:** 110-120 V, 60 cycle, 40 watts
- CONNECTORS:** Amphenol 7-pin — Power output to Model 352 Transducer and Signal input from Model 352 Transducer or Model 355 Bio-Amplifier
 Banana Jacks — Input connectors used instead of Amphenol Input
- CABLE:** 7-wire, 3-foot shielded cable for interconnecting recording module with Model 352 Transducer or Model 355 Bio-Amplifier. Amphenol connectors at each end.
- DIMENSIONS:** Width $2\frac{7}{16}$ ", height $6\frac{1}{8}$ ", length $5\frac{3}{8}$ ". (Four modules can be mounted at once on a Harvard Apparatus 10" chart mover to provide a 4-channel system; three modules can be mounted on a Harvard Apparatus 8" chart mover to provide a 3-channel system.)
- WEIGHT:** 3 pounds

THESE MECHANICAL MODULES ARE ALSO AVAILABLE FOR USE WITH THE ELECTRONIC RECORDING SYSTEM (See Bulletin 270)



270 ISOTONIC MUSCLE CONTRACTION MODULE for recording skeletal muscle contractions.



271 HEART and SMOOTH MUSCLE MODULE



275 TAMBOUR MODULE for recording breathing patterns.

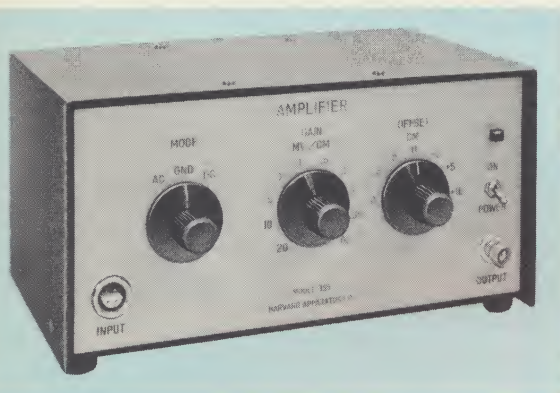


280 EVENT MARKER MODULE for use as a signal magnet.



281 EVENT/TIME MARKER MODULE provides a continuous time base as well as event markings.

MODEL 355 BIO-AMPLIFIER



To detect and record biological signals in the microvolt level, (i.e. EKG and EEG signals, etc.) it is necessary to have a high gain amplifier preceding the Model 350 Electronic Recording Module. The 355 Bio-Amplifier has been designed to amplify these very low-level signals and to supply an input to the Model 350 Recording Module. The recording module furnishes power for the amplifier.

The 355 Bio-Amplifier is a fully transistorized DC differential amplifier with matched input transistors. Its versatility allows it to be used with other recording systems. It is ideal for use with an oscilloscope for observation of fast biological phenomena.

The amplifier is housed in a small, lightweight anodized aluminum case which occupies only forty square inches of bench space. It is extremely rugged and reliable in operation.

SPECIFICATIONS OF MODEL 355 BIO-AMPLIFIER

- ELECTRONICS:** Fully transistorized, DC differential amplifier
- FREQUENCY RESPONSE:** At 20 mv./cm. — 0.1-10,000 cps. (flat)
At 20 microvolts/cm. — 0.8-2000 cps (flat)
- SENSITIVITY, MAXIMUM:** 20 microvolts/cm. pen deflection
- INPUT IMPEDANCE:** 2.2 megohms
- AMPLIFICATION, MAXIMUM:** 2500
- COMMON MODE IMPEDANCE:** 33 megohms
- COMMON MODE REJECTION:** 60 db.
- MAXIMUM OVERLOAD:** 25 volts
- CONTROLS:** *Operation Mode:* AC — AC signals amplified, DC rejected
GND — Output of amplifier is grounded
DC — AC and DC signals amplified
Gain: 10-position attenuator calibrated in millivolts/cm. pen deflection from 0.02 millivolts to 20 millivolts
Offset: Pen may be moved an equivalent of 10 cm. of pen travel in either direction
On-Off Switch
- POWER REQUIRED:** +15, 0, -15 volts — supplied by Model 350 Electronic Recording Module.
- CONNECTORS:** Input — 3-terminal connector socket
Output — BNC to oscilloscope
Amphenol to recording module
- INPUT CABLES:** 3-wire shielded input cable and connector
- PILOT LIGHT**
- DIMENSIONS:** 5" x 5" x 8" — black anodized case
- WEIGHT:** 5 pounds

ACCESSORIES AVAILABLE

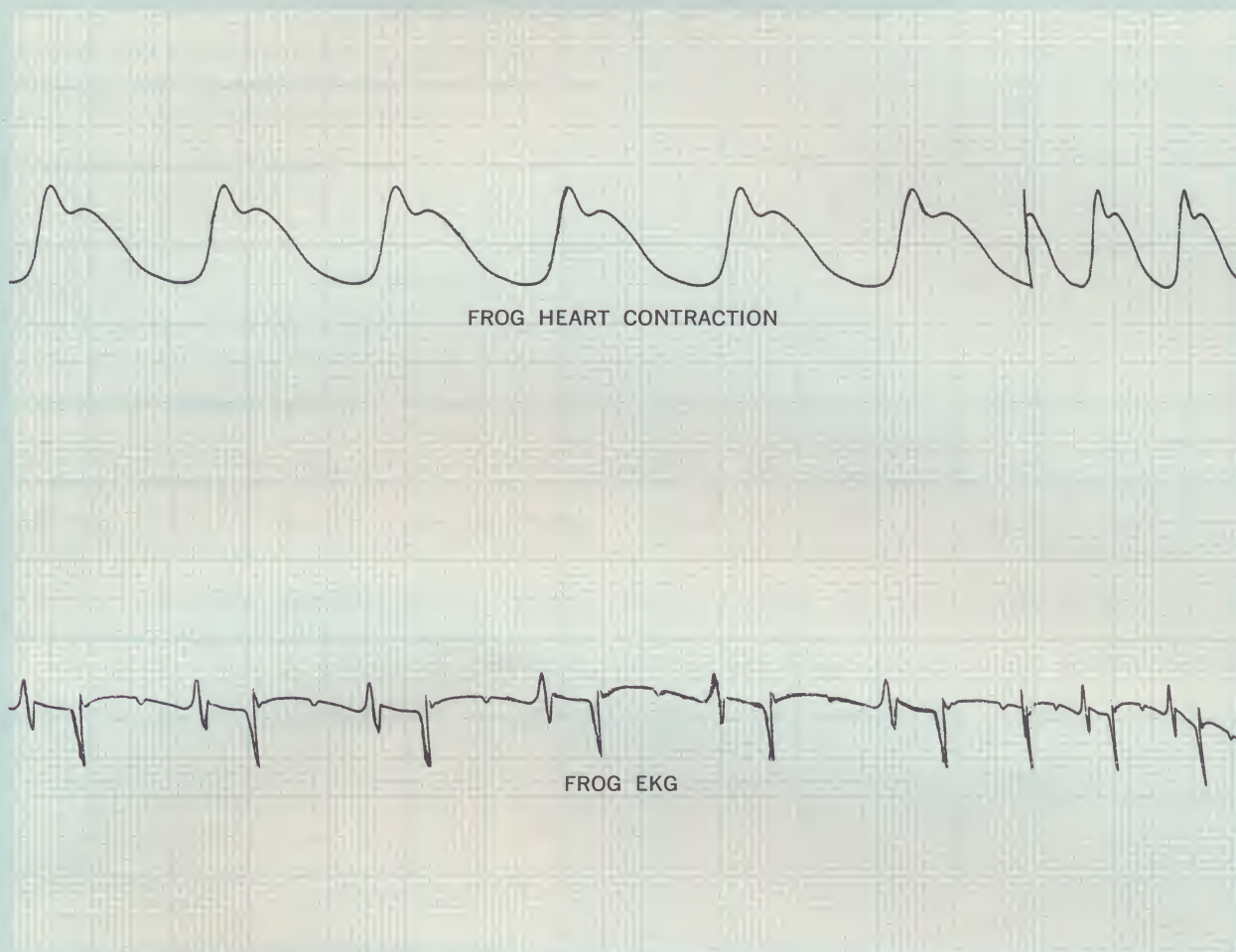
353 BIO-AMPLIFIER POWER SUPPLY A small case which attaches to the back of Model 355 Bio-Amplifier and delivers ± 15 volts to the amplifier when plugged into standard AC lines. It is required *only* when the Bio-Amplifier is not used with Model 350

Electronic Recording Module.

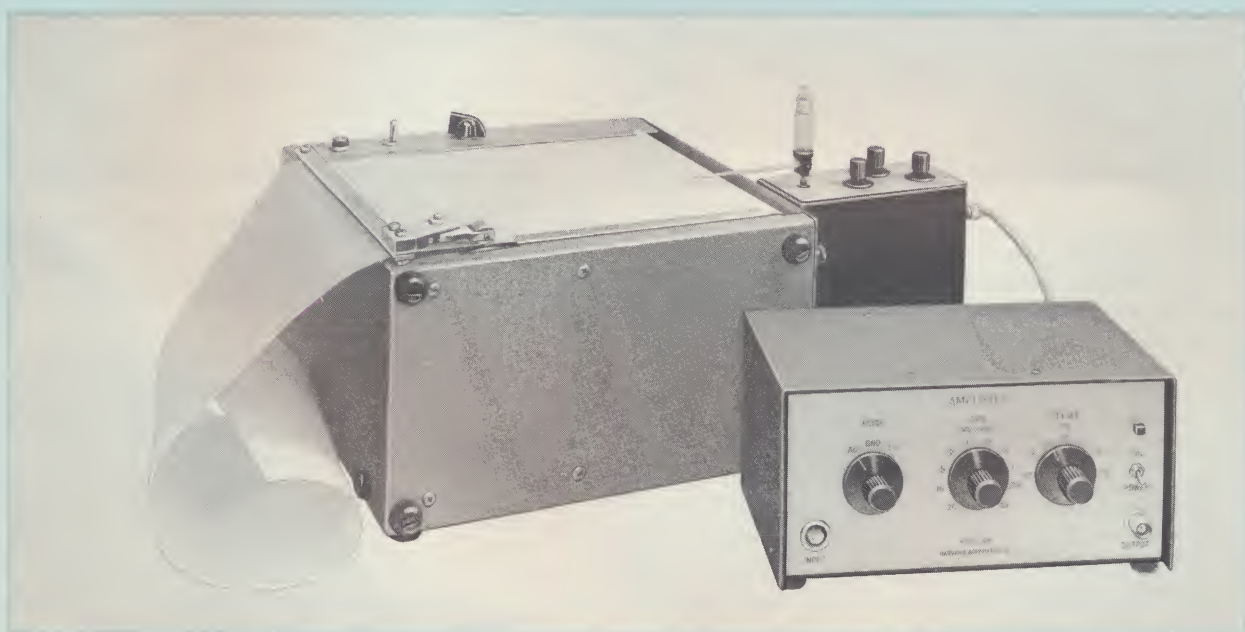
359 INTERCONNECTING CABLE A 7-conductor 4-foot cable with two Amphenol 7-pin connectors. This one cable is standard for all elements in the system.



HARVARD PHYSIOLOGICAL APPARATUS

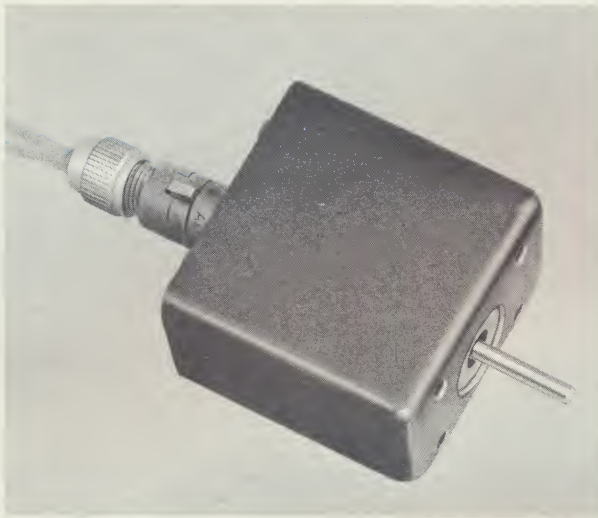


RECORDED SIMULTANEOUSLY



Model 450 Chart Mover is shown with Model 350 Electronic Recording Module and Model 355 Bio-Amplifier.

ELECTRONIC TRANSDUCERS



An electronic transducer is a device that converts mechanical phenomena (displacement, force, pressure, etc.), into a proportional electrical signal suitable for recording.

Harvard Apparatus Company, Inc., has devised a completely new type of displacement transducer (Model No. 352-2) based on the variable reluctance principle. The transducer is composed of a metal vane moving within stationary coils. Angular movement of the vane changes the inductance of the coils. Associated electronic circuitry inside the transducer element produces a D.C. voltage exactly proportional to rotation. The entire transducer element is in a sealed case that measures only 2" x 2" x 1", with a 1/8" diameter shaft 3/4" long.

Since the only moving element is the metallic vane, the friction of the transducer is limited by the precision ball bearings at either end. Quality bearings permit sensitivities better than .05 gram centimeters.

SPECIFICATIONS OF MODEL 352-2 BASIC TRANSDUCER ELEMENT

INPUT VOLTAGE REQUIREMENT:	15 volts D.C., 10 MA, Regulated
VOLTAGE OUTPUT:	.1 volt per degree of rotation
RISE TIME:	.01 seconds
OPERATING RANGE:	$\pm 15^\circ$ about the center
LINEARITY:	1% $\pm 0^\circ$ - 5° about the center 2% $\pm 5^\circ$ - 10°
TORQUE:	(Breakaway): — Less than .05 gram centimeter
CONNECTOR:	Amphenol 222-3-01, 7 pin
OPERATION:	The input shaft of the transducer has a small flat as a reference point. When the flat is horizontal the voltage output is zero. Rotation of the shaft away from the mid-position produces either a positive or negative voltage, depending upon the direction of rotation.
DIMENSIONS:	2" x 2" x 1" with 1/8" diameter shaft, 3/4" long
WEIGHT:	6 ounces

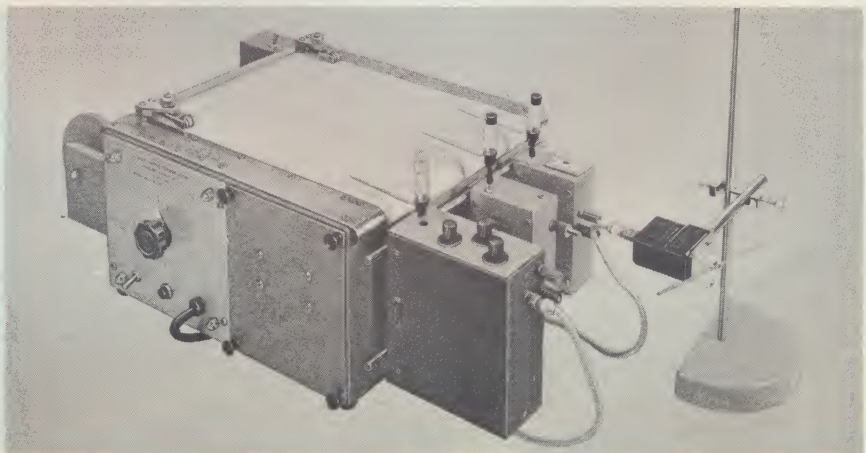
ACCESSORIES AVAILABLE

358 TRANSDUCER POWER SUPPLY A regulated power supply furnishing 15 volts DC to run the transducers. *Only required when operating the transducers without the Model 350 Electronic Recording Module.* The power supply operates from standard line voltage and is equipped with pilot light, fuse, on-off switch, 7-pin Amphenol connector and output

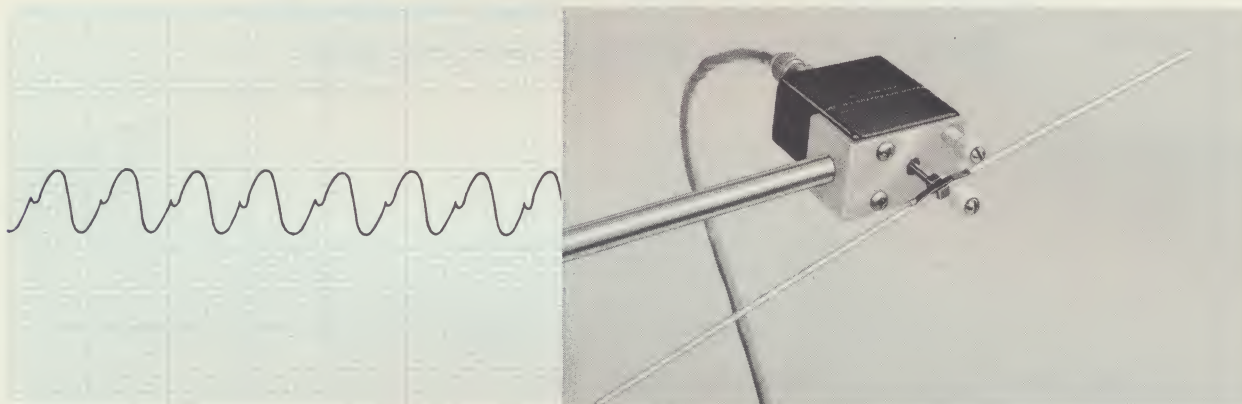
terminals. **ONE POWER SUPPLY IS NEEDED TO OPERATE EACH TRANSDUCER.**

359 INTERCONNECTING CABLE A 7-conductor, 4-foot cable with two Amphenol 7-pin connectors. This one cable is standard for all elements in the system.

Model 850 Chart Mover with Model 810 Automatic Paper Take-Up Roller being used with Model 350 Electronic Recording Module and Model 356 Heart/Smooth Muscle Transducer. Also attached to the chart mover are two mechanical modules, Model 275 Tambour (respiration) Module and Model 281 Event/Time Marker Module.

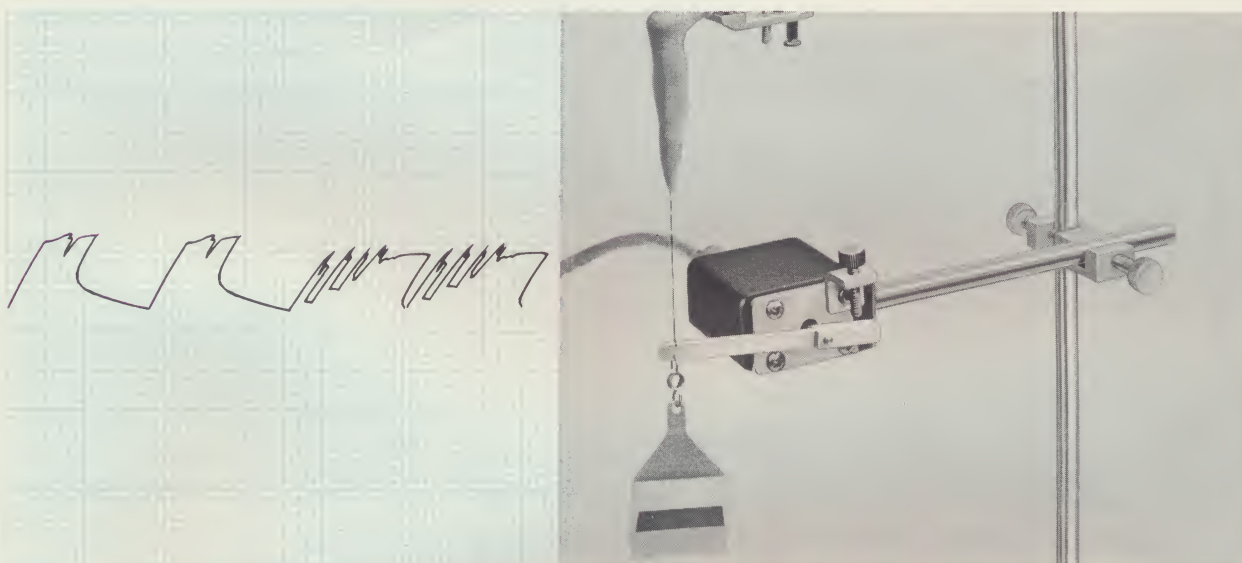


Although the transducer element is useful in itself as a building block, it is more convenient to use complete transducers designed for particular applications.



356 HEART/SMOOTH MUSCLE TRANSDUCER COMPLETE — In this application, the basic transducer element has been combined with a mounting handle, limit stops, and a light replaceable lever made from an applicator stick.

OPERATION. Clamp the transducer handle to any convenient stand and connect a thread between the lever and the preparation. The extreme sensitivity of this transducer allows the recording of the most delicate preparation without undue loading. Furnished with extra levers.



357 ISOTONIC SKELETAL MUSCLE TRANSDUCER — The basic transducer element is combined with a mounting handle, calibrated aluminum lever, after loading screw, and double hook.

OPERATION. The operation of the transducer is identical to that of a standard muscle lever. Existing femur clamps, scale pans, and weights are used with the muscle transducer. (See Bulletin 400A.)

The transducers are designed to work in conjunction with our 350 Recording Module. All of the power requirements for the transducers are contained in the recording module and one 7-conductor cable furnishes voltage to the transducers as well as pathways for the output signal. If it is desired to run transducers with other types of recorders, a 15-volt regulated power supply, and the appropriate connecting cable are required.

New types of transducers, including blood pressure, EKG lead selector, pulse pressure microphone pickup and air pressure types are under development. All new units will be fully compatible with existing recording modules, power supplies and cables. An entire family of transducers will permit recording of essentially all physical phenomena.

PRICE LIST

Cat. No.	Item	Price
281	Time Base/Event Marker Module	\$ 64.00
350	Electronic Recording Module	275.00
352-2	Basic Electronic Transducer Element	85.00
355	Bio-Amplifier	330.00
356	Heart/Smooth Muscle Transducer	95.00
357	Isotonic Skeletal Muscle Transducer	100.00

ACCESSORIES

353	Bio-Amplifier Power Supply	55.00
358	Transducer Power Supply	35.00
359	Interconnecting Cable	11.00

SUPPLIES

815	Ink, black, 8 oz. plastic bottle	2.30
816	Ink, red, 8 oz. plastic bottle	1.65
817	Ink, green, 8 oz. plastic bottle	2.30
285-2	Replacement Ink Assembly	13.00

All Prices f.o.b. Dover, Mass., U. S. A.

UNDER DEVELOPMENT

LOW COST BLOOD PRESSURE TRANSDUCER • ELECTRODES • EKG LEAD SELECTOR BOX

SERVO RECORDING MODULE 5 inch excursion, high accuracy

THERMISTOR TEMPERATURE PROBES • CARDIO TACHOMETER

UNIVERSAL OSCILLATOR BRIDGE A unit that will permit the use of any standard
carrier type commercial transducer



For Complete Catalog, write to:

HARVARD APPARATUS CO., INC. • Dover, Mass., 02030

Tel: 617-785-0700

EXPORT ONLY: Box 146, Wellesley, Mass., U.S.A. 02181

BLOOD PRESSURE TRANSDUCER
Harvard Apparatus Co., Inc.
Dover, Mass.

SPECIFICATIONS

Range- 0 - 300 mm Hg.
Accuracy- Better than $\pm 3\%$
Electrical Input- 15 VDC Regulated, Approximately 15 ma.
Electrical Output- 20 millivolts per cm of Hg.
Volume Displacement- .03 ml at 300 mm Hg.
Maximum Allowable Overpressure- 500 mm Hg.

THEORY OF OPERATION

One plate of a capacitor is the stainless steel diaphragm. Its displacement is proportional to pressure. The change in capacitance of the diaphragm pressure capacitor is compared to an internal reference capacitor by a patented electronic circuit within the transducer housing. The resulting output voltage is proportional to pressure.

The transducer is complete except for power source. The voltage output is sufficient to operate most recorders directly without the need of pre-amplifiers, bridges, etc.

Model 375 transducer has been designed to operate directly with our #350 Electronic Recording Module. In this case the transducer receives its power from, and returns the signal to, the recording module via the standard interconnecting cable.

For applications other than with our recording module, # 358 Transducer Power Supply must be used.

# 375	BLOOD PRESSURE TRANSDUCER	\$ 295.00
#358	TRANSDUCER POWER SUPPLY (only required when transducer is used with other than Harvard Apparatus recorders)	\$ 35.00

Modular **ELECTRONIC / MEC**

CHART MOVERS

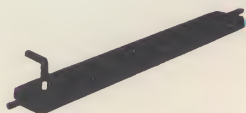
ACCESSORIES



450-810 AUTOMATIC PAPER TAKE-UP ROLLER Fastens to 450 and 451 Chart Movers and automatically winds up paper regardless of recording speed.



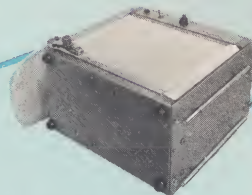
600-851 CONVENIENCE OUTLET ACCESSORY For 600-850 Chart Mover. Provides four 3-wire grounded and fused outlets installed right into the chart mover.



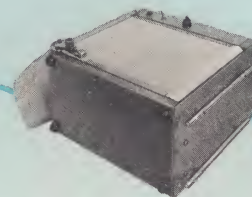
600-852 PEN LIFTER BAR For 600-850 Chart Mover. Attaches to the top of the chart mover and lifts all pens simultaneously.



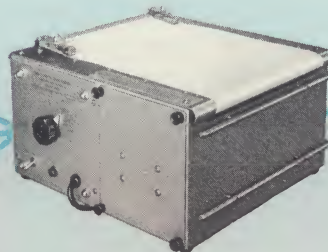
600-810 AUTOMATIC PAPER TAKE-UP ROLLER Fastens to 600-800 and 600-850 Chart Movers and automatically winds up paper regardless of recording speed.



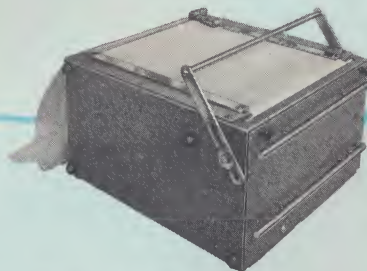
450 CHART MOVER Accepts 8" wide rolls of either plain or millimeter grid paper. Paper speeds over a 150 to 1 range from 2200 mm./min. to 13 mm./min. Operates either horizontally or vertically.



451 CHART MOVER Identical to Model 450 except that all speeds are reduced by a factor of 10. (i.e. 1.3 mm./min. to 220 mm./min.)



600-850 CHART MOVER Especially designed for modular recording. Accepts 10" wide rolls of either plain or millimeter grid paper. 12-position gearbox produces exact speeds from 0.0025 cm./sec. to 12.5 cm./sec. Furnished with double-roll drive. Operates only in horizontal position.



600-800 CHART MOVER Accepts 10" wide rolls of paper either plain or millimeter grid. Paper speeds over a 5000 to 1 range from 0.005 cm./sec. to 25 cm./sec. Operates either horizontally or vertically.

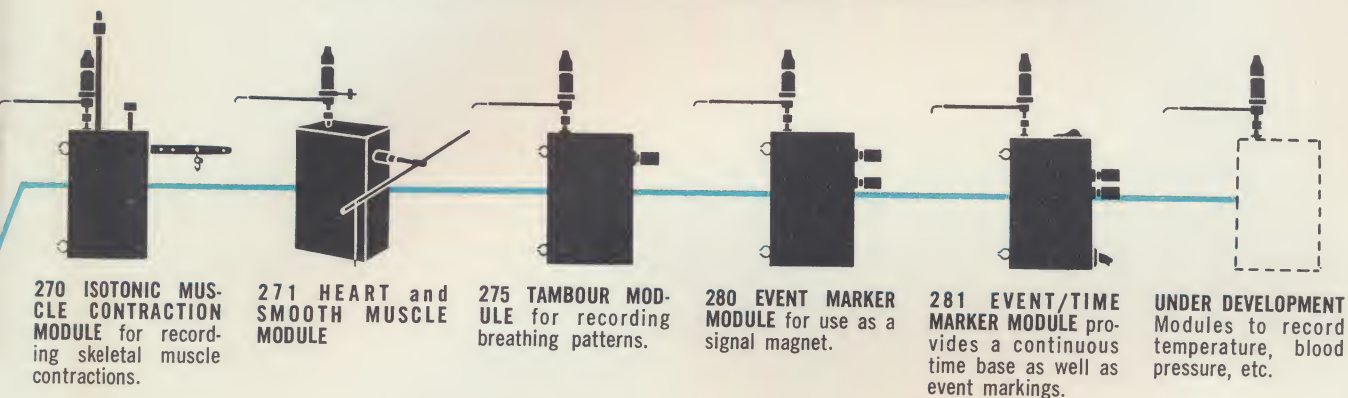


HARVARD APPARATUS CO

(a non-profit organization)

MECHANICAL RECORDING SYSTEMS

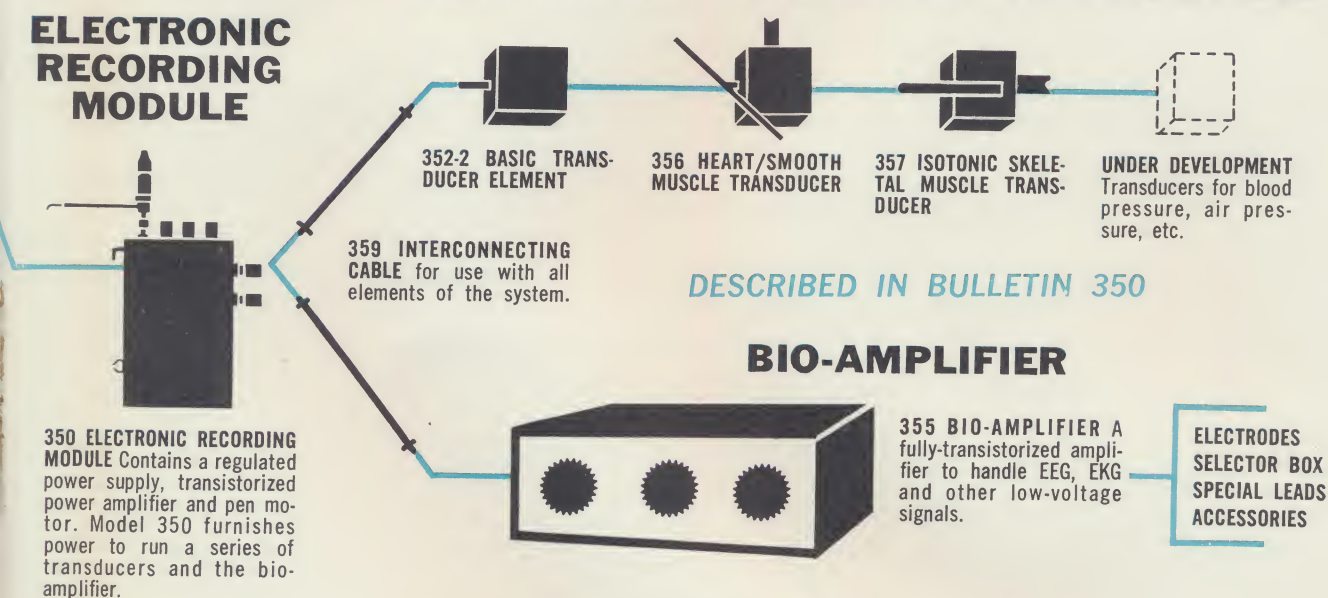
MECHANICAL RECORDING MODULES



DESCRIBED IN BULLETIN 270

ALL MODULES FIT ALL CHART MOVERS

MECHANICAL-TO-ELECTRIC TRANSDUCERS



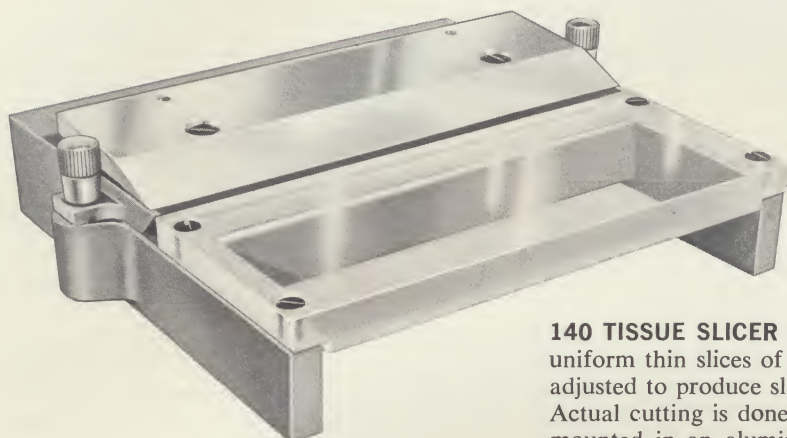
DESCRIBED IN BULLETIN 350

NOTE: On occasion the Harvard Apparatus transducers and bio-amplifier will be required to operate with other systems or with an oscilloscope. For these cases, we offer Model 353 Power Supply for the Bio-Amplifier, and Model 358 Power Supply for the transducers.

(See Bulletin 350.)

MPANY, INC. Dover, Mass., U.S.A. 02030

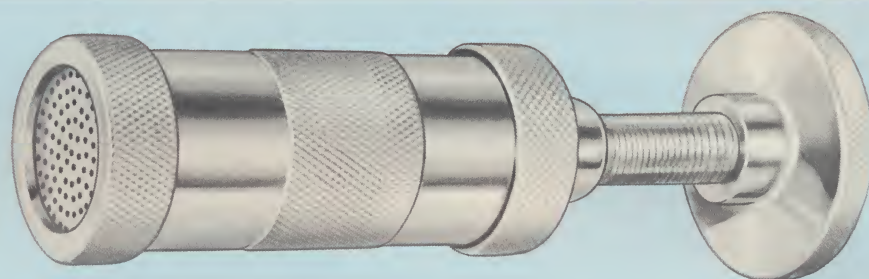
TISSUE AND ANIMAL PREPARATION



140 TISSUE SLICER A simple apparatus for the preparation of uniform thin slices of brain, liver, etc. *The device can be easily adjusted to produce slices from 0.1 mm. to 3.0 mm. in thickness. Actual cutting is done by use of a 6" section of disposable blade mounted in an aluminum holder set on a cast aluminum base. Thickness adjustment is varied by use of shims made of folded aluminum foil. (One thickness of foil equals approximately 15 μ .) Complete with four blades.

**G. Majno and W. E. Bunker Preparation of Tissue Slices for Metabolic Studies: A Hand Microtome Especially Suitable for Brain. Journal of Neurochemistry, 1957, Vol. 2. Pages 11-14.*

140-RB REPLACEMENT BLADE

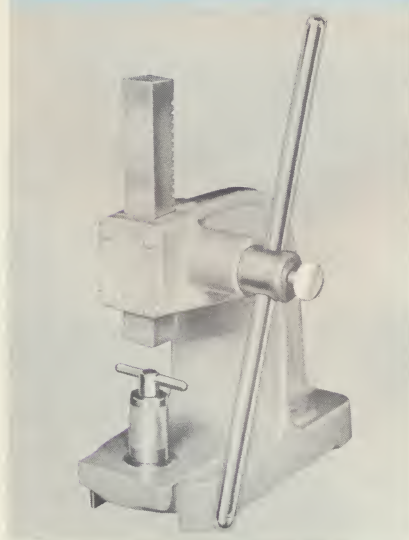


141 TISSUE PRESS A screw type press for the removal of connective tissue in the preparation of homogenates. Ruggedly constructed of #303 stainless steel, the entire device is easily disassembled for cleaning. Both a coarse and a fine sieve are furnished. The two sieves can be used at the same

time to provide very fine openings. Approximate capacity of 30 cc. of material.

141-4 REPLACEMENT FINE SIEVE for 141 Tissue Press.

141-5 REPLACEMENT COARSE SIEVE for 141 Tissue Press.



142 ARBOR TISSUE PRESS A heavy duty version of the #141 Tissue Press, operated by a one ton press instead of a screw. Total capacity of 9 cc. of material. Maximum pressure of 6000 p.s.i. possible. Handles heart, muscle and other tough tissues with ease.

Tissue holding chamber made of #316 stainless steel and completely removable for cleaning.

Furnished with two sieves, 1 mm. and .5 mm. perforations.

142-13 SERRATED TISSUE GRINDER PLUNGER A special hardened serrated plunger is available for the grinding of particularly tough preparations. In operation, the serrated plunger is rotated under pressure thus grinding the preparation between the serrated teeth and the sieve. The serrated plunger is interchangeable with the standard plunger.

142-7 REPLACEMENT FINE SIEVE for 142 Arbor Tissue Press.

142-8 REPLACEMENT COARSE SIEVE for 142 Arbor Tissue Press.

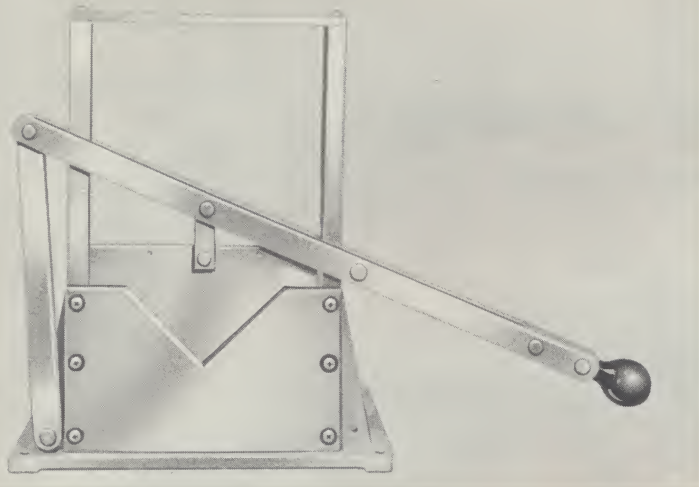
142-10 TISSUE PRESS ASSEMBLY for 142 Arbor Tissue Press.

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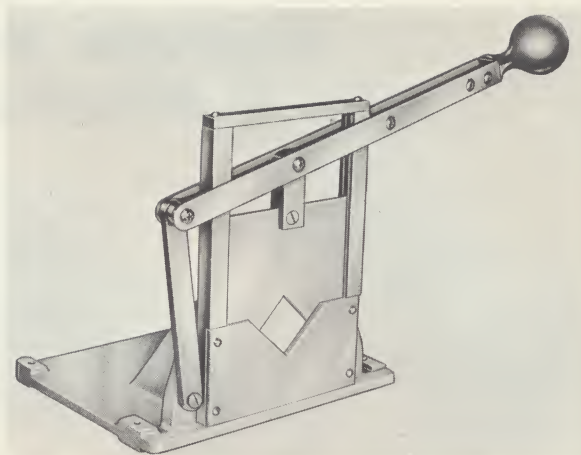


HARVARD APPARATUS CO., INC.

DOVER, MASSACHUSETTS 02030



135 LARGE ANIMAL DECAPITATOR For rabbits and other large laboratory animals. Blades open to a 4" square and are of type 410 stainless steel, ground to Rockwell 60. Heavy cast aluminum base, machined and Polyvinyl Chloride coated, has holes for table-top mounting. All parts are of anodized aluminum, stainless steel, or nicked brass. The lever arm is 26" long. Dimensions are 14" x 9" x 16½"; weight is 20 lbs.



130-RM DECAPITATOR A simple rugged device for the instant decapitation of rats and mice. Stainless steel blades and fittings with cast aluminum base for bench mounting. Can be totally immersed for cleaning. Opens to 1½" square.

Overall dimensions: base 8" x 6"; height 8¼".

ANIMAL ACCESSORIES



118 SEEKER A probing instrument of solid stainless steel for blunt dissection. The eye may be threaded for ligation of blood vessels.

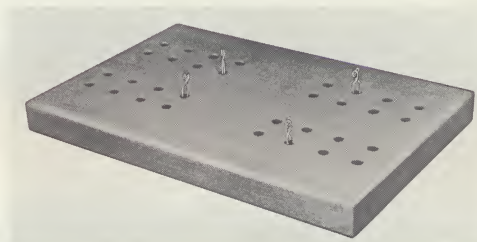


120-48 ANIMAL BOARD — DOG A washable, light-weight non-rusting, one piece anodized aluminum dog cradle. 48" long, 14" wide by 4" high. Strong channel construction supports 200-pound loads. Pitched drain-age trough. Furnished with plastic thongs, and rubber tipped feet to protect table tops.

120-36 ANIMAL BOARD — CAT Same as 120-48 except 36" long by 12" wide and intended for use with cats.

120-SR SIDE RODS A set of four stainless steel rods 7" long with wing nuts. These are designed to fasten

vertically on the edge of the 120 animal boards. Useful for holding apparatus or supporting the animal's head.



700 FROG BOARD A waxed hardwood operating board for frog experiments measuring 9" x 6" x 7/8". Six stainless steel clips supplied can be inserted into the holes to secure frogs of any size.

700-C REPLACEMENT FROG BOARD CLIP



701 ARTERY CLIPS Chromium plated steel clips for closing off blood vessels. Approximately 1½" long.

CAT. NO.	PRICE	CAT. NO.	PRICE	CAT. NO.	PRICE
118	2.50	140	48.50	142-8	18.00
120-36	30.00	140-RB	.70 ea.	142-10	75.00
120-48	33.00	141	75.00	142-13	25.00
120-SR	6.00	141-4	11.50	700	3.00
130-RM	55.00	141-5	11.50	700-C	.15 ea.
135	150.00	142	135.00	701	1.45
		142-7	20.00		

For Complete Catalog, write to:

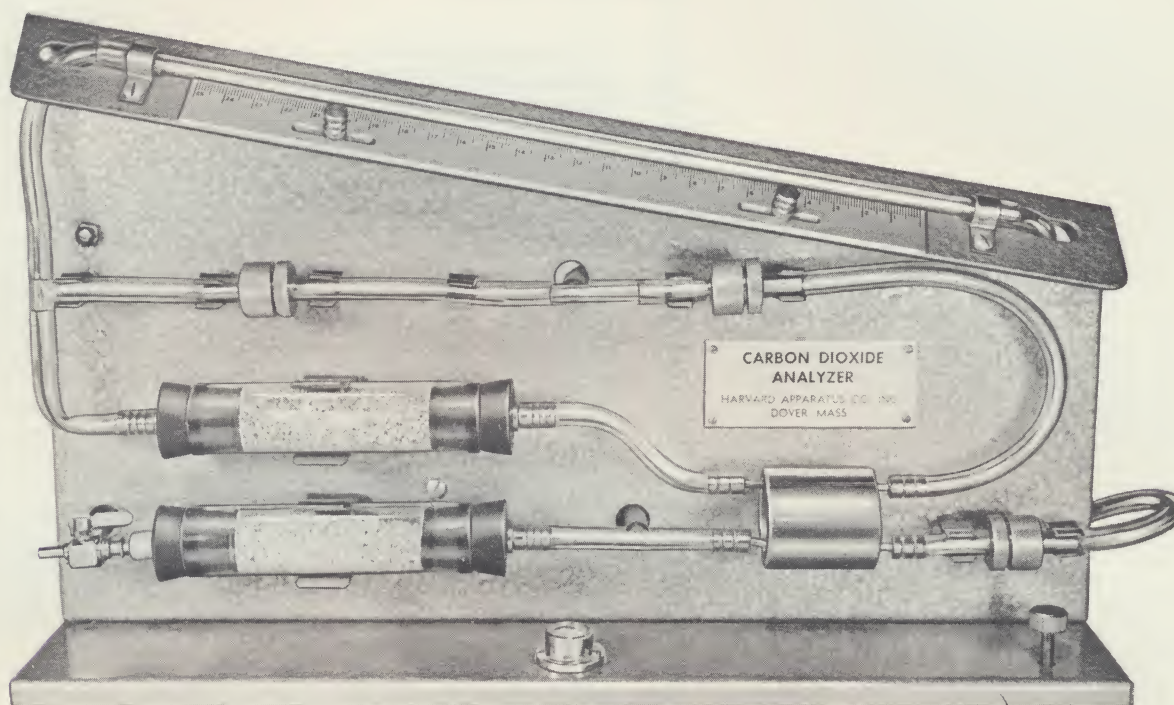


HARVARD APPARATUS CO., INC. • Dover, Mass., 02030

Tel: 617-785-0700

CONTINUOUS CARBON DIOXIDE ANALYZER

MODEL NO. 2000



A simple CO₂ Analyzer based on the critical orifice principle*

The Analyzer is particularly suited for continuous analysis of both expired gas and alveolar gas (e.g. as provided by Rahn end-tidal sampler) in student phys-

iology laboratories. The sampling rate is such that the unit can be used in series with a Pauling oxygen analyzer.

INDEX

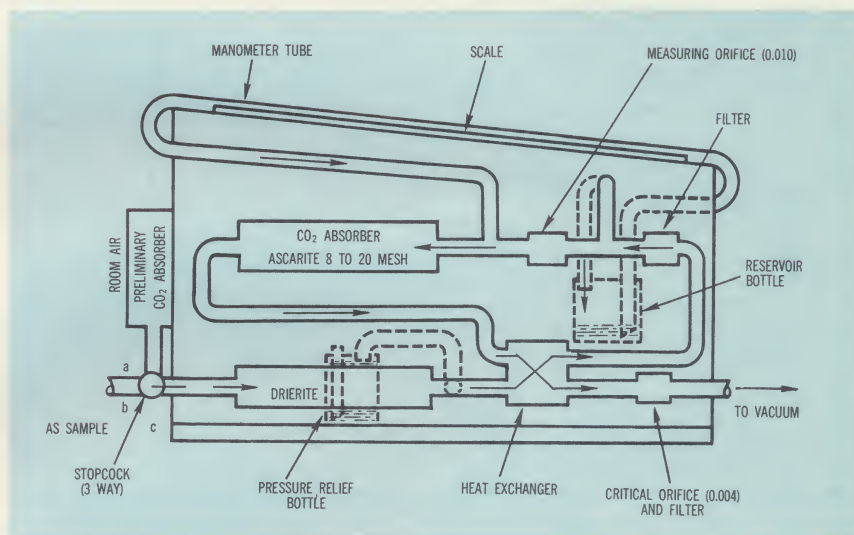
3

PRINCIPLE OF OPERATION

If a dry gas mixture is passed through a chamber containing a CO₂ absorbent, the volume of gas passing into the chamber in a given time will equal the volume leaving the chamber (under the same conditions of pressure and temperature) if there is no CO₂ in the mixture. If CO₂ is present in the mixture and all of the CO₂ entering the chamber is absorbed, then A, the total volume of gas entering the chamber in a given time will exceed B, the volume leaving the chamber in the same time interval, as related by the equation

$$A = B \times \frac{1}{1 - F_{CO_2}}$$

where F_{CO_2} is the fraction of CO₂ in the entering gas.



*J. Mead. A critical orifice CO₂ analyzer suitable for student use. *SCIENCE*, Vol. 121, Pages 103-4, 1955.

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and Allied Sciences.



HARVARD APPARATUS CO., INC.

DOVER, MASSACHUSETTS 02030

In practice the rate of outflow is maintained at a nearly constant level by means of a critical flow orifice. The pressure on the downstream side of the orifice is maintained at less than half an atmosphere by means of a water-jet filter pump. The diameter of the orifice is approximately 0.004 in., permitting a gas flow of about 100 ml./min.. The gas sample flows into the chamber through a second orifice of larger diameter (about 0.01 in.). The pressure drop across this second orifice is measured and indicates the rate of flow into the chamber. This pressure drop is approximately 10 cm. of water when dry CO₂-free air is sampled. Since the outflow is maintained at a nearly constant level, the flow through the measuring orifice must increase as the fraction of CO₂ in the test gas increases. For example, if the dry sample contains 5% CO₂, the rate of flow through the measuring orifice increases approximately 5% from zero CO₂ conditions. In this instance, the measuring orifice pressure drop increases approximately 10%, for it varies as the square of the rate of flow through it. To accomplish adequate resolution of such a pressure change, a reservoir manometer is used, slanted 10° over the operating range with gauge oil as the fluid. The CO₂ absorbent used is Ascarite 8-20 mesh (sodium hydroxide fused on asbestos).

SPECIFICATIONS

Sample Flow Rate: 100 ml./min.

Range: 0 to approximately 10% CO₂

Response Time: 2 to 3 minutes for final reading

Accuracy: $\pm 0.05\%$

Vacuum Requirement: simple water-jet filter pump or equivalent that will maintain vacuum of $\frac{1}{2}$ atmosphere.

Orifices: synthetic sapphires

Chemicals Supplied: Ascarite, Drierite and gauge oil

CO₂ Analyzer, complete \$145.00 f.o.b. Dover, Mass.



For Complete Catalog, write to:

HARVARD APPARATUS CO., INC. • Dover, Mass., 02030

Tel: 617-785-0700

EXPORT ONLY: Box 146, Wellesley, Mass., U.S.A. 02181